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REFINER
AND NATURAL GASOLINE MANUFACTURER
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The Look Box

THE American Petroleum Institute's Department of Statistics has announced that it is not unreasonable to expect an increase of approximately 4 percent in motor fuel demand in 1939. Likewise its study indicates a probable increase in demand of 15 percent for furnace oils used in heating homes next year.

4%

These estimates are based on sound reasoning and are interpreted from the forecasts of the automotive industry, the general upward trend of indicated business progress, and various other influencing factors. It is estimated that on January 1, 1939, about 26,850,000 motor vehicles will have been carried over from 1938. If the automobile industry's figures of 3,000,000 new vehicles in 1939 are sold during next year, there will be in use at the end of 1939 approximately 27,850,000 units after allowing for those to be scrapped or replaced. The estimates, of course, are based upon the continuation of improved business conditions and should this prove not to be the case, as we progress into next year, these opinions will, of course, have to be revised, but the outlook, as nearly as it can be observed at this time, justifies the figures arrived at.

The number of home-heating burners in use has almost doubled in the last five years and indications are at present that this winter will probably record an average of 1,690,000; this figure indicating a considerable increase over the 1,550,000 burners used in homes last winter. Should this heating season be representative of the average of the last five, it should register approximately 5 percent more degree-days of heating than last winter. Interpreting such figures in relation to demand, it appears reasonable to estimate that approximately 15 percent more furnace oils will be used in heating homes than the 63,000,000 barrels consumed a year ago.

In addition, continued progress in industry generally should see an appreciable increase demand for the heavier fuel oils and for the various types of industrial lubricants.

AN important announcement relative technical achievement coming out of the research efforts of the petroleum industry occurred in the disclosure that a commercial process is now in operation for the synthetic manufacture of glycerine from petroleum gases.

Glycerine

E. C. Williams, vice president of Shell Development Corporation in addressing the dinner session of the Institute of Petroleum at its meeting in Chicago recently announced that his company has had in operation for

more than a year a commercial plant which synthetically produces glycerine from cracking plant gases. Perfection of this highly important process comes as a result of many years of scientific research, which work was described briefly by Dr. Williams. He described the various steps in the process and the types of mechanical equipment, controls, and technique.

The average price of the highest grades of glycerine over a period of years has been around 15 to 16 cents a pound, with fluctuations from 10 to as high as 70 cents, he stated, and as a result of the perfection of the new process the price can be stabilized. He stated that the value of the synthetic product from petroleum is in making a universally used commodity, and with no intent to compete with existing supplies to drive prices down to unprofitable levels. However, should the capacity of the existing industry fall below requirements at any time due to marked increase in needs, the petroleum industry can now step quickly into the breach.

The quality of the synthetic glycerine is equal to, if not better than, the best product now on the market and the cost of production leaves a comfortable margin for profitable commercial operation at present price levels, which are already on the low side.

Glycerine is widely used in soaps, medicines, lotions, foodstuffs, and scores of other commodities. In time of war the obvious step from glycerine to nitroglycerine is but a simple one, widely employed. The refining industry, if called upon can supply vast quantities of glycerine for war-time purposes.

Schuler Crude

THE Schuler field in Union County, Arkansas, is one of the most active oil fields in the state at present. The crude oils produced in this field come from three general horizons; the oils from the highest producing formation, the Morgan zone (Lower Trinity) are of the paraffin base type, while those from the deeper levels, the Jones sand (Lower Marine) and Reynolds Lime are intermediate in character, according to the Bureau of Mines system of classification.

Samples of crude oil from the Schuler field have been collected and analyzed by the Bureau of Mines. A sample from the Morgan "D" sand has a gravity of 41.9 A.P.I. and a sulfur content of 0.54 percent, a carbon residue of 2.3 percent, and is a paraffin base oil; whereas a sample from the Jones sand has a gravity of 32.1 A.P.I., a sulfur content of 1.55 percent and a carbon residue of 3.8 percent and is intermediate in base. This is one of the rare cases where a paraffin base crude oil is produced from an upper horizon in relation to intermediate or naphthene base oil from lower horizons.

The Schuler field was discovered in April, 1937, following geophysical exploration. Its total productive area has not yet been determined. While a portion of the production comes from a few wells in the Morgan zone at 5500 to 6000 feet, the greatest production at present is from the Jones sand at 7500 feet. A few wells also have been drilled to the Reynolds lime at 7600 feet.

The Morgan "D" sand crude yields 30.5 percent of gasoline and naphtha of 65.6 A.P.I. gravity and 18.7 percent of 47.4 A.P.I. kerosene. Gas oil totals 12.2 percent at 38.8 A.P.I. gravity, with heavier distillates totaling 15.7 percent and a residuum of 19.2 A.P.I. gravity totaling 22.1 percent.

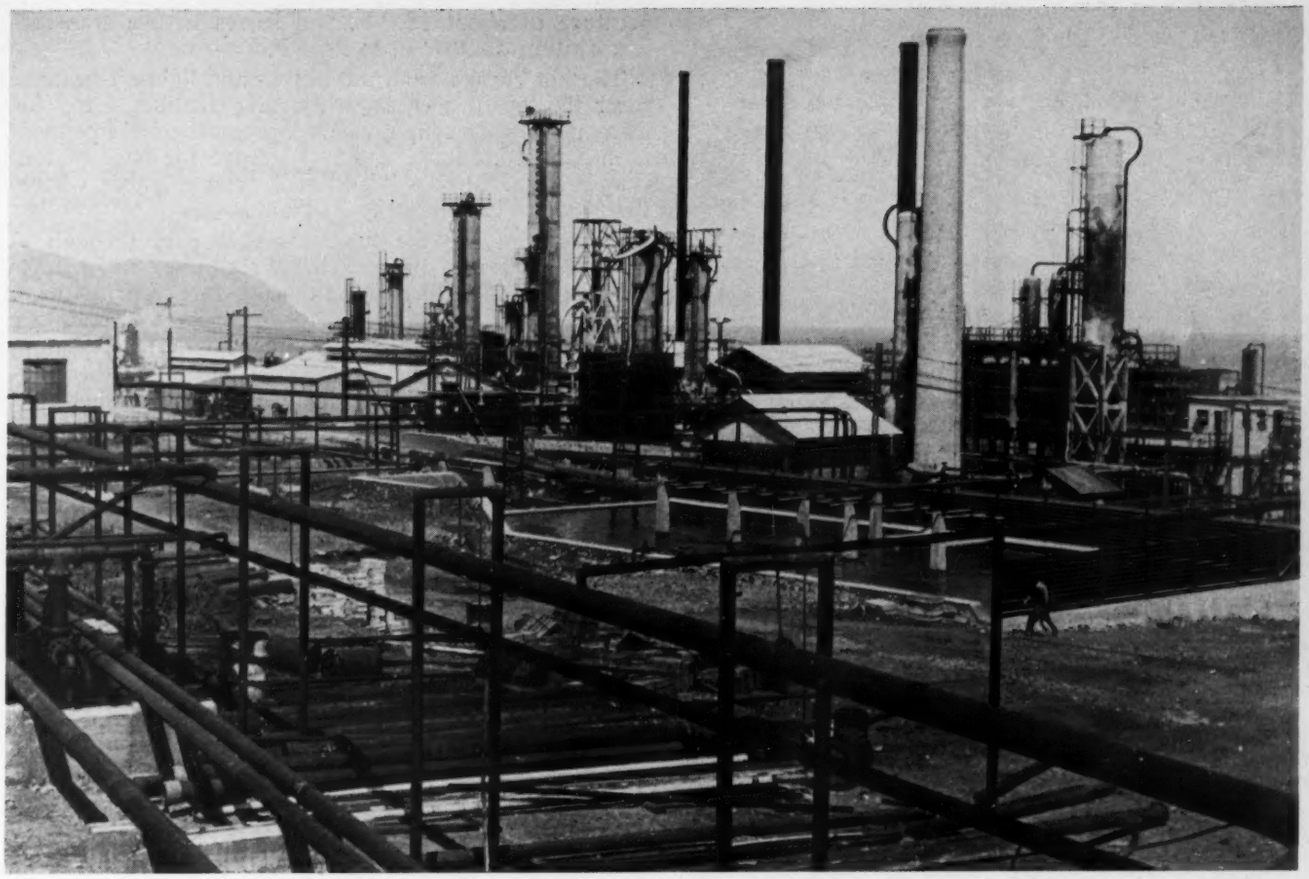
The oil from the Jones sand yields 25.4 percent total gasoline and naphtha of 60.5 A.P.I.; kerosene 9.6 percent of 43.2 A.P.I.; gas oil, 14.5 percent of 35.8 gravity, with total heavier distillates 15.9 percent and with 33.9 percent of 13.8 A.P.I. gravity residuum.

New Crude

THE crude oil produced from the recently discovered deep pay horizon (Avenal sand presumably of Eocene Age) in the Eastside Coalinga field, Fresno County, California, is an intermediate base oil having a gravity of 33.4 A.P.I. and a sulfur content of 0.22 percent, according to analysis made by the Bureau of Mines, on a sample obtained from Gatchell Well No. 1, completed during June, at 6814 feet.

For the past 30 years wells on land located adjacent to the new production have been producing a good grade of refining oil from depths of 1400 to 3500 feet. A composite sample of oil from these older wells collected in 1928 had a gravity of 24.0 A.P.I. and a sulfur content of 0.45 percent. The distillation summary of that oil includes 14.7 percent gasoline and naphtha, no kerosene distillate, 29.4 percent gas oil and 23.7 percent of heavier distillates.

The Gatchell No. 1 well has been estimated to have a potential production of 20,000 barrels per day. Since it was brought in three additional wells have been completed in the immediate vicinity, each of which is believed to have an equal potential to the discovery well. The distillation summary of the newly developed oil includes light gasoline of 71.2 gravity, 7.6 percent, and total gasoline and naphtha 26.9 percent of 55.2 A.P.I. gravity. Kerosene distillate, with gravity of 33.6 totaled 4.4 percent; and there was 22.6 percent of gas oil of 29.9-25.9 A.P.I. gravity. Heavier distillates totaled 20.2 percent with 23.0 percent of 13.9 A.P.I. gravity residuum. The carbon residue of the crude was 2.2 percent and carbon residue of the residuum was 9.4 percent.



Improvement

Program at Tenerife Plant, Canary Islands, Completed

FREDERICK C. RING

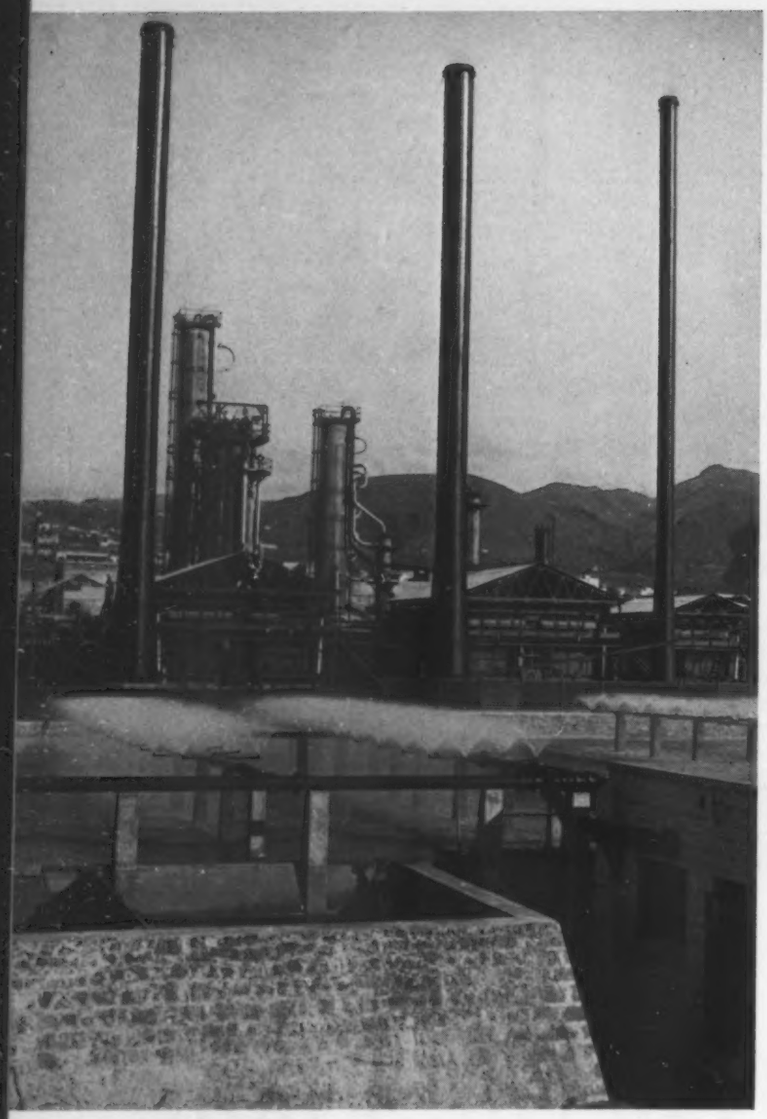
A MAJOR refinery construction program, comprising a cracking unit, vacuum-rerun unit, centrifuge and doctor-treating plant, gas-collecting system, a general extension to the boiler and power plant, auxiliary equipment and tank farm was recently completed at the refinery of the "Compania Espanol de Petroleos, S. A." at Santa Cruz, Tenerife, Canary Islands, and put into operation.

The Dubbs unit which combines heavy and light oil cracking, semi-reforming, absorption recovery system, stabilizing and debutanizing embraces the latest features in cracking unit design.

While specifically designed to crack light high-sulphur crude, the unit is sufficiently flexible to handle a wide range of cracking stocks, including the reforming of naptha produced by the existing viscosity breaker.

Though having a rated capacity of 5000 barrels of 35 A.P.I. crude per day, the unit averaged 5560 barrels during its initial run of 26¾ days on stream with a yield of 64 percent of 392 end point gasoline, having an octane number of 68. A distillation of the composite gasoline shows an initial of 96° F. and when plotted forms a straight line without tails at either end of the graph.

The residuum had a gravity of 5.6 A.P.I., viscosity 200 S. F., with B. S. and solids averaging 0.04 percent. In the current operation crude is charged to the unit by a 14 x 7½ x 12 inch duplex pump, passing progressively through a reflux exchanger where the temperature is raised to about 240° F., then to a pressure settling tank maintained at a pressure of 200 pounds per square inch, where the water is continuously drained off. The charge oil then continues through a residuum exchanger, vapor-heat exchanger and enters a separately-fired crude heater at a temperature of about 425° F. and leaves with a



Compania Espanol de Petroles, S. A. at Santa Cruz, Tenerife, Canary Islands. General view of cracking department, left to right is heavy oil heater, light oil heater and crude oil heater.

transfer-line temperature of 550° F., is discharged on a stripping plate of an 18-bubble-deck crude fractionating column 8 feet diameter x 52 feet high. Here two streams are removed. The 250° F. end point overhead stream is pumped directly to storage, while the naptha sidecut passes through a stripper. This naptha, alone or blended with naptha from the viscosity breaker is picked up by a 3 x 12 inch duplex plunger pump driven by a 10 x 12 inch horizontal steam engine which delivers the naptha to the discharge line of the light-oil hot-oil pump where it blends with the light oil from the cracking column sidecut and passes through the light-oil heater. The light-oil sidecut from the cracking column is handled by a 5 x 18 inch duplex plunger pump driven by a 16 x 18 inch horizontal steam engine.

Topped crude is drawn from the base of the crude fractionating column by a 14 x 7½ x 12 inch duplex charge pump and pumped to the mid section of the cracking fractionator where it serves to cool the vapors and blends with the bottoms, forming the heavy-oil charge. The heavy-oil charge is drawn from the base of the cracking fractionator by a 6½ x 24 inch duplex plunger driven pump driven by a 16 x 18 inch steam engine, and delivered to the heavy-oil heater at a temperature of about 680° F. and leaves with a transfer temperature of 910° F. to 925° F.

The hot charge from the heavy- and light-oil heaters enter the top of a common reaction chamber 6 feet in diameter x 40 feet high, where a pressure of 215 pounds is maintained. Liquid and vapor leave the base of the chamber and enter a 9 x 40 foot flash chamber where the pressure is reduced to 72 pounds.

Vapors leaving the flash chamber pass through a vertical shell and tube exchanger to the 9 x 73 foot cracking fractionator, where the pressure is maintained at 65 pounds.

A 14 x 7 x 18 inch simplex surge pump takes suction from the base of the flash chamber and pumps the residuum through a double pipe exchanger, exchanging heat with crude, then through a submerged coil cooler to storage.

The overhead from the cracking fractionator enters a 4 x 33 foot secondary column, equipped with a reboiler utilizing a side cut from the cracking fractionator as a heating medium. The pressure distillate is fractionated into two products, a light overhead 250 end point which is stabilized, debutanized and sent to storage, and a heavy pressure distillate 400 end point bottoms which is pumped directly to storage. These products receive separate treatment in the treating plant. The fixed gas from the separator together with the fixed gas from the viscosity breaker pass through a 4 x 33 foot absorption column at a pressure of 55 to 60 pounds. Naphtha is used as an absorption medium, the rich absorber bottoms being returned to the cracking column for recovery of the light products. A side cut from the cracking column furnishes heat for the reboiler.

Predetermined amounts of cold topped crude may be combined with the heavy-oil charge in the cracking column or topped crude only, may be cracked by bypassing the crude section. The topping section may be operated independently as a topping unit while the cracking section is down for cleaning or repairs.

Three Lummus radiant heaters of suspended wall, flat arch construction, enclosed in steel casing, with air ventilated foundations, comprise the furnace installation. The firing tunnels are arranged along the side walls at right angles to the tube banks, each tunnel being equipped with a combination oil and gas burner. The crude heater has an actual capacity of 5600 barrels of crude per day, distilling off a 250-end point overhead and a naphtha sidecut. The heater has 12 firing tunnels located along one sidewall, with the conversion tube bank installed between a longitudinal bridge wall and the outer side wall. The charge passes progressively through the conversion bank, roof tubes and floor tubes. The conversion and roof tubes are 4½-inch O.D. and the floor tubes 5 inch O.D., all of carbon steel. The heavy-oil heater is divided into two combustion chambers by two longitudinal bridge walls with the conversion bank in the center between the bridge walls. Twelve firing tunnels are arranged along each side wall. The flow through this heater is divided, half of the total charge passing through each combustion chamber. The oil enters the bottom of the conversion bank, and flows progressively through the roof and floor tubes, then joins in a common discharge line. The roof and floor tubes are 3½ inches O. D. and the conversion tubes 4 inches O. D., all tubes and fittings are 4-6 percent chrome 0.5 Molybdenum alloy.

The light oil heater is similar except that the flow is not divided, but passes progressively through the conversion section, floor tubes in left hand chamber,

roof tubes, the floor tubes in right hand chamber. The conversion tubes are 3 inches O. D. and the roof and floor tubes 4 inches O. D., all tubes and fittings of chrome, Molybdenum alloy.

The control and regulating equipment used in conjunction with the operation consists of air actuated recording controllers regulating the reflux discharge to control the temperature at the top of the fractionators, recording pyrometers for transfer and crossover lines in the heaters and indicating pyrometers for less important points. Liquid-level controls are provided for the columns and flash chamber and a liberal use of air actuated control valves help to maintain a uniform pressure throughout the system.

Every precaution has been taken to reduce corrosion. The walls of the reaction chamber, flash chamber and the lower section of the cracking fractionator are lined with an alloy steel ⅛ inch thick. All fittings, valves, level controls, and piping subjected to corrosion are of 4-6 percent chrome, 0.5 Molybdenum alloy. All piping is electric welded,

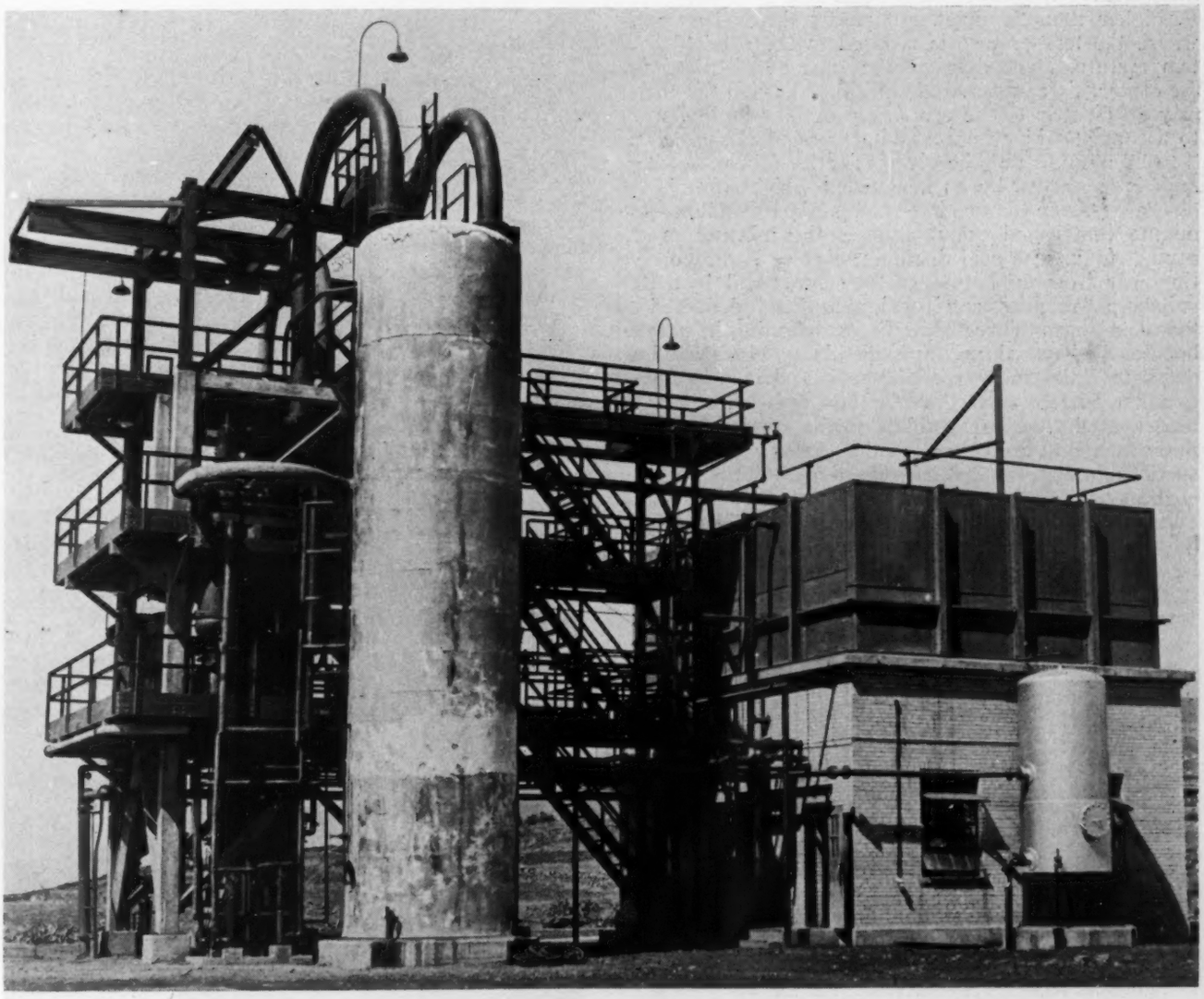
TREATING

Straight-run gasoline from the Dubbs unit, the viscosity breaker and the light pressure distillate receive only a water wash, caustic wash, and doctor treat.

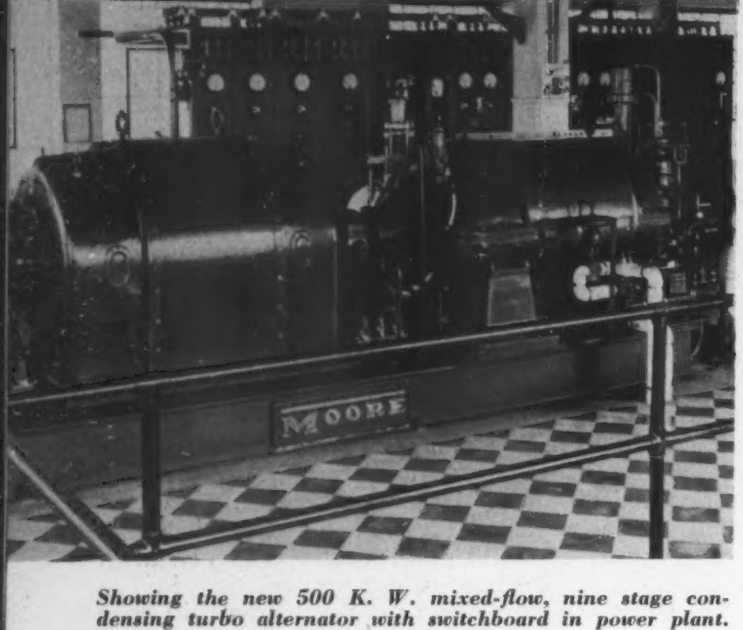
The heavy pressure distillate is acid treated, rerun, then doctor treated and blended with the straight-run gasoline and light pressure distillate.

The acid-treating section of the treating plant has a capacity of 3000 barrels per day. A 100-gallons-per-minute centrifugal pump delivers the raw heavy pressure distillate to the first stage of the process. A portion of the charge is diverted by an orifice located in the charge line to a reciprocating type meter which actuates a steam valve on the proportionometer. This is a steam-driven positive displacement piston pump which delivers a predetermined volume of acid into the charge at the entrance of the mixer. The steam end of the acid pump is cross connected to a similar pump delivering a caustic solution to the acid treated and desludged pressure distillate. The percentage of acid per barrel may be varied by increasing or reducing the length of the piston stroke. When it was found that the volume of caustic solution delivered by the proportionometer was insufficient for thorough diffusion and that the time of contact was too short for proper neutralization, a conventional caustic circulating system was substituted.

The mixer is of the horizontal agitator type driven by a 5-horsepower motor. The mixture of acid and dis-



Vacuum distillation unit used for redistillation work. CEPSA plant at Santa Cruz, Tenerife, Canary Islands.



Showing the new 500 K. W. mixed-flow, nine stage condensing turbo alternator with switchboard in power plant.

tillate leaves the mixer at a temperature of about 12° F. higher than the inlet and passes through a cooler where the temperature is reduced to the original inlet temperature. Depending on the type of distillate and the contact time required, the distillate leaving the cooler may go directly to the centrifuge or may be by-passed to a contact tank where a contact period ranging from 2 to 20 minutes may be given. The level in the contact tank is controlled by an instrument which controls the discharge from the charge pump. A 100-gallons-per-minute centrifugal pump agitates the mixture in the contact tank. The acid distillate mixture is drawn continuously from the bottom of the contact tank by a 100-gallons-per-minute centrifugal pump and delivered to the centrifuges. Three centrifuges operating in parallel handle the treated pressure distillate. The desludged distillate flows to a receiving tank and is transferred to a 7 x 16 foot vertical settler at a pressure sufficient to deliver the treated distillate to the storage tanks. A line connecting the bottom of the settler with the pump suction circulates a 20° Be'. caustic solution. Sludge is continuously drawn off to sludge storage. It was found that a 3-minute contact period conserved acid and produced the best all around results when operating on heavy pressure distillate from Iraq crude.

Treating heavy pressure distillate from 35.6 A.P.I. Iraq crude:

	Raw Feed	Treated and Rerun
Gravity	47.8° A.P.I.	
I.B.P.	215° F.	216° F.
E.P.	397° F.	396° F.
Sulphur	0.23 percent	.097 percent
Gum		8 Milligrams
Corrosion		Negative
Color	Yellow	+30 Saybolt
Acid per barrel	4.25±66° Be.	

Stability—2 hours strong sunlight—lost 8 points color.

Assay of Polymer

Gravity	25.4° A.P.I.
I.B.P.	395° F.
E.P.	460° F.

Loss

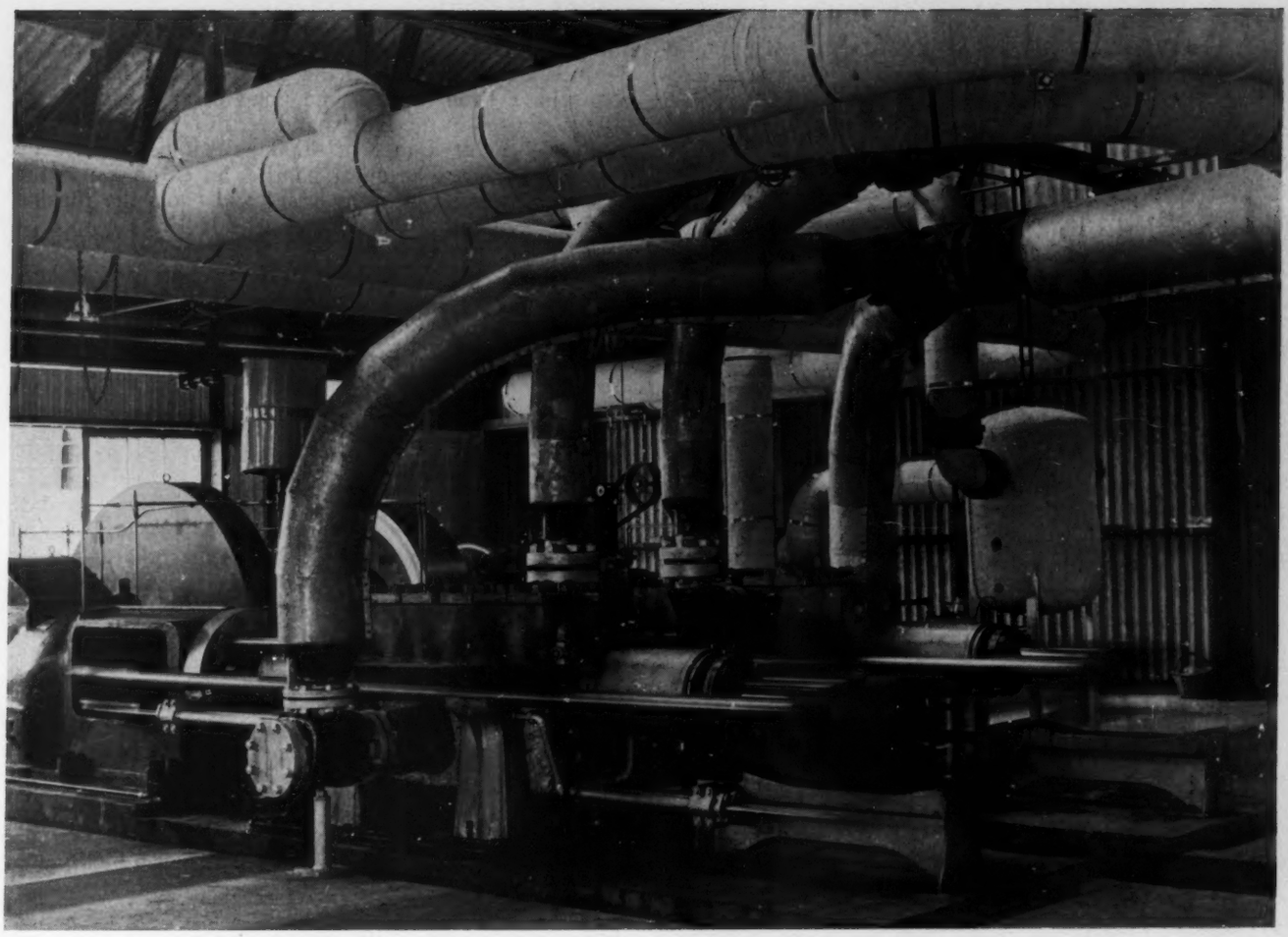
Volumetric treating loss	1.9 percent
Polymer loss	3.9 percent
Rerun loss	1.1 percent
Total	6.9 percent

REDISTILLATION

The acid treated heavy pressure distillate is rerun in a 3000 barrel Badger combined atmospheric and vacuum unit, all heat required for distillation being supplied by vapor-heat exchange and steam-heated elements. A motor-driven centrifugal charge pump takes suction from the treated pressure distillate tanks and discharges progressively through a shell-and-tube exchanger located in the atmospheric vapor stream, through a steam heated preheater, then enters the mid section of a 5 x 27 foot atmospheric tower where 30 to 50 percent of the charge is vaporized, the amount varying with the type of charge. The bottoms from the atmospheric exchanger are drawn by vacuum through a shell-and-tube preheater and enter the vacuum tower at a temperature of about 290° F. Additional heat is supplied to the vacuum tower by 4 steam coils located on the 4 bottom plates. In usual practice only 2 of these coils are used. Spray steam is admitted to the base of the tower at a rate of 4.7 pounds per barrel. The vapors pass from the vacuum tower through two shell-and-tube condensers in series, the condensate being collected in a vacuum header where the fixed gases are released. A vacuum of 60 mm absolute is maintained on the tower outlet by a two-stage ejector. Simplex pumps remove the overhead condensate and vacuum bottoms. The atmospheric and vacuum overhead streams pass through water separators, weir boxes, then to a common receiving tank where they blend. A submerged-coil cooler is provided for final cooling.

A centrifugal pump furnishes reflux for the atmospheric tower while reflux for the vacuum tower is introduced by vacuum. Liquid level controls are provided for the drawoffs of the towers, vacuum headers and distillate receiving tanks. Controls for the raw feed charge rate and recording thermometers recording the temperature at the top and feed inlet of both towers are provided. Proportioning pumps are provided to introduce a caustic solution into the raw feed and both towers when necessary. In normal operation the total steam consumption averages 74 pounds per barrel and the total water 260 gallons per barrel of raw charge. When rerunning distillate without introducing caustic

Main pumping plant at the cracking unit. Left foreground is the light oil hot oil pump, and at right is the heavy oil hot oil pump, both driven by horizontal steam engines.



Light oil hot oil pump installation charging the light oil heater.

solution there is no overlap between the end point of the blended overhead and the initial boiling point of the vacuum bottoms. When a caustic solution was introduced compounds were formed which decomposed at a temperature of about 400° F., lowering the boiling point of the vacuum bottoms about 30° F.

DOCTOR TREATING

The doctor section of the treating plant treats 5500 barrels per 24 hours, this relatively high capacity facilitating the early treatment of distillates containing H_2S before decomposition occurs.

In routine operation, straight-run, light and heavy pressure distillate are cycled, then blended to specification.

The straight-run and light pressure distillate from Iraq crude receive no acid treatment, but are given a preliminary water wash, and caustic wash to remove the H_2S and light mercaptans. Suction is taken from the intermediate storage tanks by a 175-gallons-per-minute centrifugal pump and discharged through an orifice to the mixing nozzles. Water amounting to 25 percent of the distillate is injected into this line on the upstream side of the nozzles, the mixture entering the water-settling tank where the water is continuously drawn off, the distillate flowing to the caustic settler. A 26° Be' solution of caustic soda is introduced into the transfer line by a centrifugal pump to remove the remaining H_2S and light mercaptans. The caustic-treated distillate then receives a doctor treat, the doctor solution being introduced into the flow line leaving the caustic settler. Mixing is effected by three mixing nozzles. A dual ratio control system interlocks the distillate and doctor solution flow, introducing a definite percentage of solution into the distillate. Free sulphur is introduced by diverting a portion of the H_2S free distillate through a drum filled with broken lump sulphur. The sulphur-bearing distillate is injected into the flow line to the primary doctor settler between the first and second mixing nozzles. Two doctor settlers are provided, most of the spent solution precipitating in the first settler. The treated distillate receives a final water wash and is discharged to the storage by the pressure carried in the treating system.

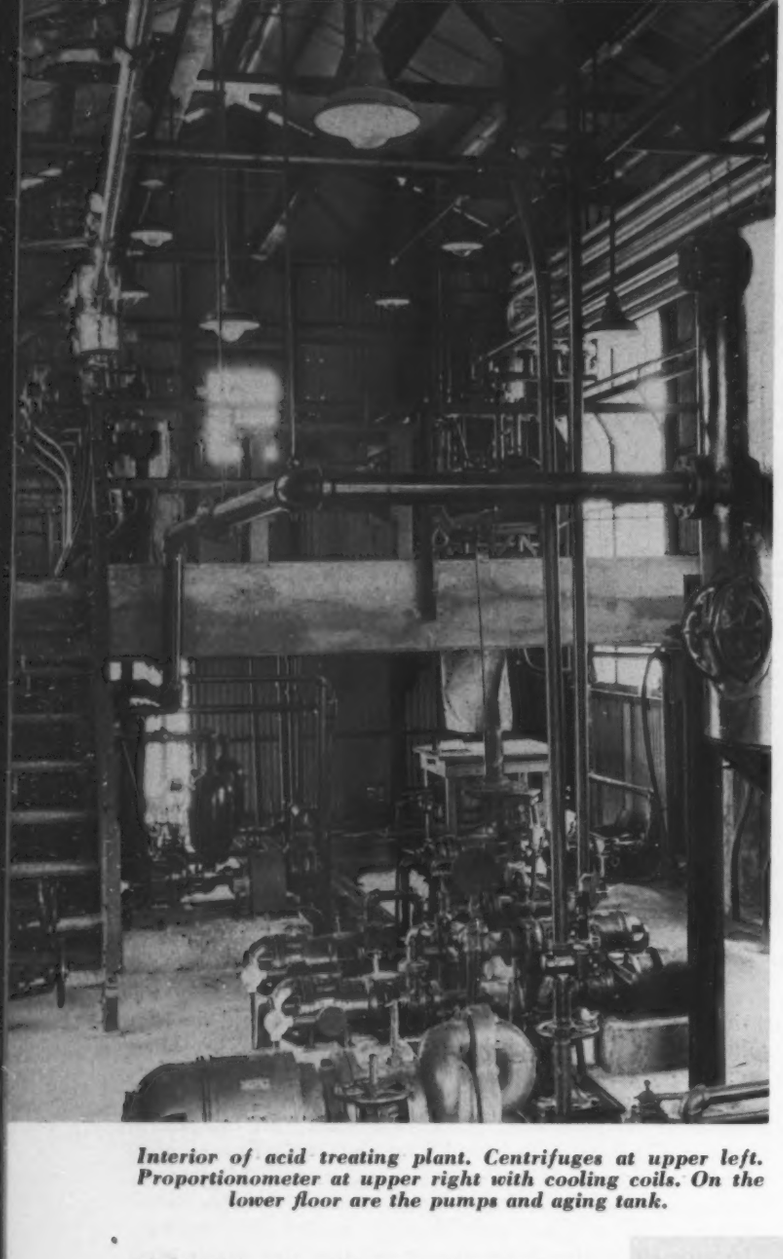
The level in all settlers is maintained by interface level controls and the spent doctor from both settlers is discharged to the doctor recovery unit. Once regulated, the operation of the unit is automatic, requiring a minimum of attention. The rerun heavy pressure distillate receives a similar treatment except that the caustic wash is omitted.

Assay of Doctor Treated Light P.D.

	Before	After
Gravity	74.2° A.P.I.	74.1° A.P.I.
I.B.P.	98.6° F.	99.4° F.
E.P.	296° F.	295° F.
Color	+29.5	+30
Sulphur	0.175 percent	0.047 percent
Gum		3 milligrams
NaOH—lbs. per bbl.		1.65
*Pbo—lbs. per bbl.		0.53

*Pbo actually consumed. This amount is reduced to an average of 0.21 pounds per barrel by the doctor recovery unit.

There are two systems for the recovery of fixed gas and vapors, a low-pressure system collecting vapors



Interior of acid treating plant. Centrifuges at upper left. Proportionometer at upper right with cooling coils. On the lower floor are the pumps and aging tank.

To meet the increased water demand a new 6-inch line brings a fresh water supply from the reservoirs in the hills a few miles from the plant and two new spray ponds have been added. One pond cools the condensing water used in the Dubbs and rerun plants from 130° F. to 85° F. at a rate of 4000 gallons-per-minute by double spraying. The other pond is an extension to the existing power plant spray pond and cools the turbine condenser water from 100° F. to 80° F. at a rate of 1000 gallons-per-minute.

All tanks are equipped with foam-mixing chambers with double pipes terminating outside of the dykes. Foam ejectors, hose and cans of powder are stored at convenient locations in the various areas. A constant supply of water for fire service is stored in a 100,000-gallons elevated tank located at the highest point in the refinery. All tanks are enclosed by stone walls, this type of construction being necessary due to the steep hillside on which the refinery is built.

The original boiler and power installation consisted of two 500-horsepower cross-drum water-tube boilers and two 125 KW mixed flow, turbo-generators with their accessories. To meet the increased demand two new 500-horsepower boilers of the same type with feed water heaters have been installed. All of the boilers are equipped with oil and gas burning sets, and normally operate at 150 percent rating.

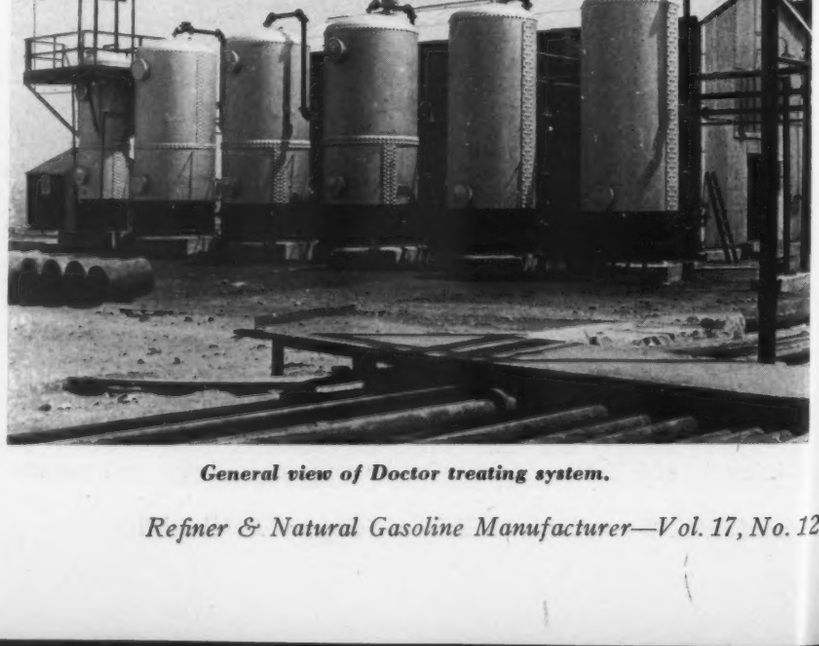
One 500 K.W. mixed flow, 9-stage condensing turbo alternator with 2-pass surface condenser and 2-stage air ejector has been installed and the switchboard and building extended. Under usual operating conditions the exhaust steam from the Dubbs unit and viscosity breaker, balance the low pressure steam requirements for power and processing. The live steam is maintained at 160 pounds gauge at the boiler house and the low pressure steam at 20 pounds. Current is generated at 440-460 volts, three phase, 60 cycles.

The original plant consisting of a 5000-barrel Badger viscosity breaker, rerun unit, continuous-treating plant, power plant, tankage and auxiliaries and the new extension were designed, built and placed into operation by Bethlehem Steel Company.

Since completion of the original plant in 1931, the refinery has been under the management of Don Demetrio Carceller, director general, Don Juan Lliso Moreno, general manager, and Don Jose Canellas, refinery manager.

from the crude and light-oil tanks and a high-pressure system conveying the gas produced by the viscosity breaker to the absorption unit in the Dubbs area. The tanks are equipped with combination vacuum and relief valves with flame arresters. A control valve installed in the collecting line at each tank opens when the pressure in the tank reaches 2 ounces and maintains a balanced pressure in the system. The collecting lines connect with the suction of a blower located in the gas-compressor house which discharges into the fuel-gas main at a pressure of 5 pounds, blending with the residual gas from the absorption plant.

A compressor takes suction at the viscosity breaker separator and delivers this gas to the absorber at 55 pounds pressure, blending with the Dubbs gas.



General view of Doctor treating system.

Cracking

Northern Wyoming

Light and Black Oils

At Laureleaf Refinery

J. C. ALBRIGHT

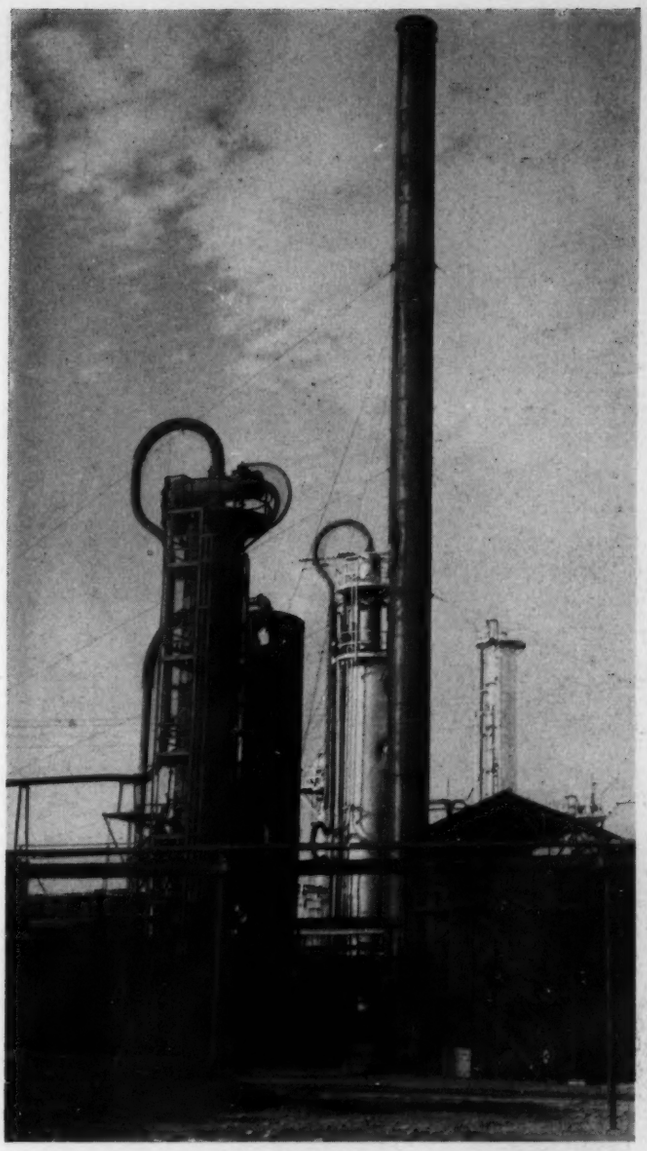
HAVING been engaged in running both light and heavy oils produced in Wyoming and southern Montana for a number of years, Independent Refining Company recently enlarged its facilities at Laurel, Montana, with a Dubbs cracking unit, and revamped heavy-oil reduction equipment for production of more satisfactory grades of asphaltic products, which include road oils, crack fillers, cut-backs and roofing compounds. The plant is designed for independent processing of fresh crude charge, so that the cracking plant may be operated with selected stocks, or run with fresh crude charged in the usual manner.

The black oils of this area are asphaltic and are suitable particularly for manufacture of road materials. The light oils are high-gravity-gasoline-producing crudes, which are sometimes combined with the black oils in processing for high-octane motor fuel manufacture. In the manufacture of gasoline, a representative day's run on the Dubbs cracking unit is shown as follows:

GAS OIL CHARGE

	Barrels	Gravity	Percentage
Gas Oil	1,420.91	26.9° API	100.00
P. D.	731.65	51.49° API	51.49
Dist.	142.33	35.30° API	10.02
Residue	457.80	12.00° API, 70 vis.	32.22
Gas & Loss	89.13		6.27
	1,420.91		100.00

When running heavy oil from Cowley-Byron field near Lovell, Wyoming, the charge averages about 3000 barrels daily, which is charged through overhead reflux condensers and shell-and-tube exchangers of products-to-charge, and enters a preliminary flash drum at a temperature of 280° F. From this vessel, the partially stripped crude is pumped to the skimming and reduction furnace with a transfer temperature of 765° F., entering the flash drum above the eighth tray at a pressure of 20 pounds, gauge. The charge enters the column at sufficient height that penetration asphalt may be manufactured in the vessel without additional processing, if desired. The bottoms from the flash chamber are

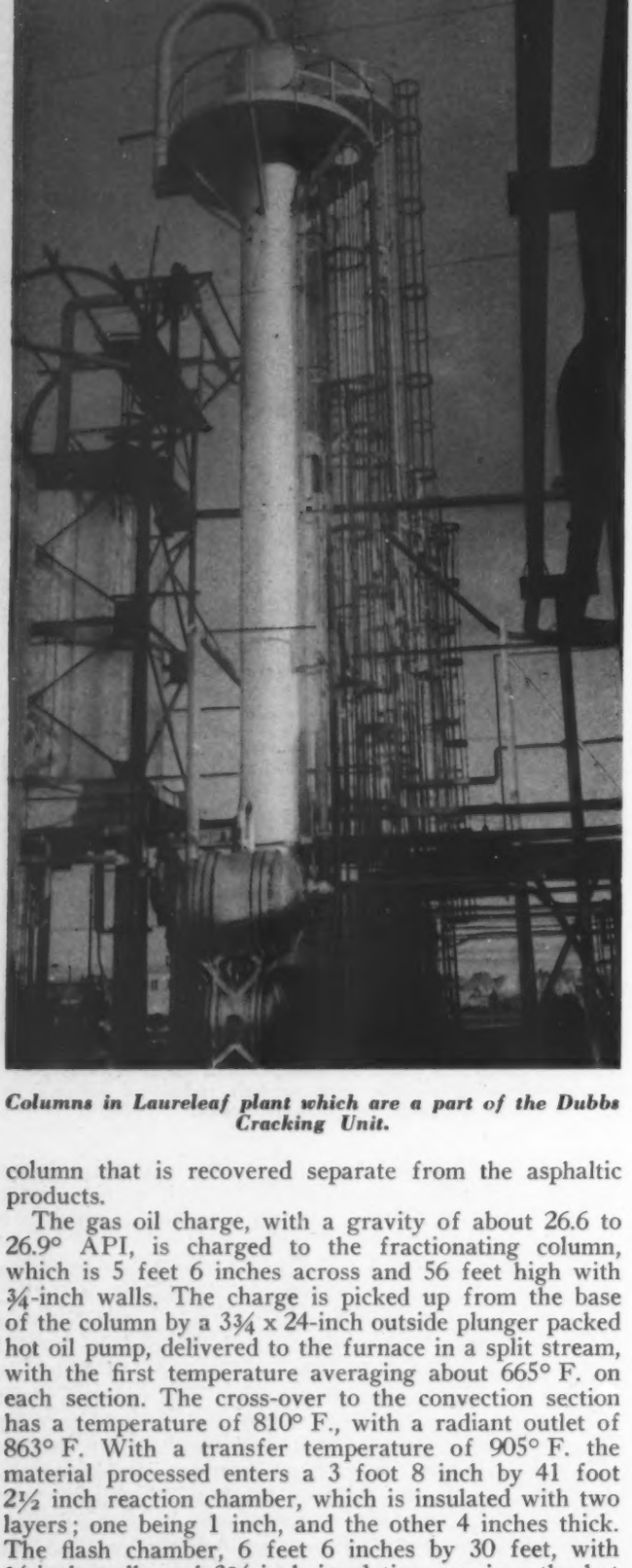


View of Laureleaf plant of Independent Refining Company from skimming section with asphalt reduction column at side of furnace stack.

pumped as reduced black oil to the vacuum column heater, if further processing is desired, with an inlet temperature of 670° F., and a transfer temperature of 775° F.

Gasoline is obtained from the overhead line from the fractionating column, which has a gravity of 66° API, an end point of 355° F., and plus 30 color. It is disposed of by blending back with cracked gasoline in desired proportions and finished by addition of Q fluid, or leaded for high-octane motor fuel. The reduced black oil under a vacuum of 22 inches Hg., is processed by proper manipulation of flow and time to any desired grade of products. Two-stage vacuum distillation may be followed, as the vacuum column is equipped with three sections, so that the charge may be pumped from one to the other for efficient stripping of gas oil and lighter fractions than desired for asphaltic products.

When running light oil, the amount that can be handled is reduced, as more of the lighter fractions are available and the residuum, being of mixed base, is reduced to industrial fuel oil. When cracking, a gas oil charge is used, derived from the several streams of skimming, plus the material removed in the vacuum



Columns in Laureleaf plant which are a part of the Dubbs Cracking Unit.

column that is recovered separate from the asphaltic products.

The gas oil charge, with a gravity of about 26.6 to 26.9° API, is charged to the fractionating column, which is 5 feet 6 inches across and 56 feet high with ¾-inch walls. The charge is picked up from the base of the column by a 3¾ x 24-inch outside plunger packed hot oil pump, delivered to the furnace in a split stream, with the first temperature averaging about 665° F. on each section. The cross-over to the convection section has a temperature of 810° F., with a radiant outlet of 863° F. With a transfer temperature of 905° F. the material processed enters a 3 foot 8 inch by 41 foot 2½ inch reaction chamber, which is insulated with two layers; one being 1 inch, and the other 4 inches thick. The flash chamber, 6 feet 6 inches by 30 feet, with ¾-inch walls and 3½-inch insulation, receives the hot processed oil through an 8-inch line and a 6-inch series 30 nozzle, and is operated with a top temperature of 782° F., and at a pressure of 65 pounds, gauge.

An 8-inch line leads vapors to the fractionating column. This has 16 bubble plates and 10 side-to-side pans, with a draw-off section between the twelfth and thirteenth plates. The fractionator is operated at 672° F. at bottom, light oil draw-off at 522° F. and top 375° F., controlled with reflux from the pressure distillate receiver drum. Vapors from the fractionating column immediately enter a Gray tower, with top at 362° F. and outlet 383° F. and bottom at 354° F., with polymers returned to charge stock. The pressure distillate then enters the second column for end-point control, and is stabilized at once to pressure required for altitude and climatic conditions. The stabilizer is operated at 155 pounds, gauge, with base temperature at 340° F., charge inlet of 230° F., and top, 105° F., controlled with reflux.

The light oil draw-off section furnishes material for wall wash, quenching, reboiler heating and for absorption of desired fractions from vapors not condensed in the main condenser from the secondary fractionating column. The absorber, 36 feet by 33 inches, with 16 plates takes gas from the pressure distillate receiver drum in counter current flow to absorption oil, with residue passing to plant fuel lines for consumption in furnaces and plant boilers.

Gasoline recovered from the stabilizer has the following specifications:

IBP	84° F.
5 cc. over	115° F.
10 cc. over	131° F.
20 cc. over	168° F.
30 cc. over	204° F.
40 cc. over	238° F.
50 cc. over	267° F.
60 cc. over	291° F.
70 cc. over	316° F.
80 cc. over	334° F.
90 cc. over	365° F.
95 cc. over	388° F.
Dry point	392° F.
Recovery	96%
Loss	3%
API gravity	59.5°
Color	+26
Octane number	69.0
RVP	10.1 pounds
Barometer	27.33 inches Hg.

Gas oil produced in the plant is as follows:

Initial boiling point	270° F.
5 cc. over	473° F.
10 cc. over	500° F.
20 cc. over	545° F.
30 cc. over	585° F.
35 % over	600° F.
API gravity	26.6°
Barometer	27.30 inches Hg.

Distillate, which is used for tractor and Diesel fuel has the following inspection:

DISTILLATE

Initial boiling point	385° F.
5 cc. over	408° F.
10 cc. over	411° F.
20 cc. over	416° F.
30 cc. over	420° F.
40 cc. over	424° F.
50 cc. over	428° F.
60 cc. over	432° F.
70 cc. over	436° F.
80 cc. over	442° F.
90 cc. over	453° F.
95 cc. over	470° F.
API gravity	35.5°
Recovery	99%
Dry point	495° F.

All crude, whether heavy black oil, or light paraffinic oil is shipped into the plant by truck and trailer, unloading equipment being supplied in the plant yard where loads may be dumped in one underground reservoir without detaining automotive equipment.

The Application of *Propane* to the Manufacture of *Pennsylvania Lubricating Oil*

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CHANGES in the competitive situation and in the average viscosity of motor oils have adversely affected the status of the refiner of Pennsylvania lubricating oils.

To correct the situation it appears advisable to install new processes which will reduce costs, improve quality, and produce an increased amount of effective neutral from the crude.

Propane dewaxing and deresining have been shown to reduce manufacturing costs, to increase the amount of effective neutral, and to prepare stocks for efficient single solvent treatment.

This paper was presented before the 1938 Annual Meeting of the National Petroleum Association, Atlantic City, New Jersey.

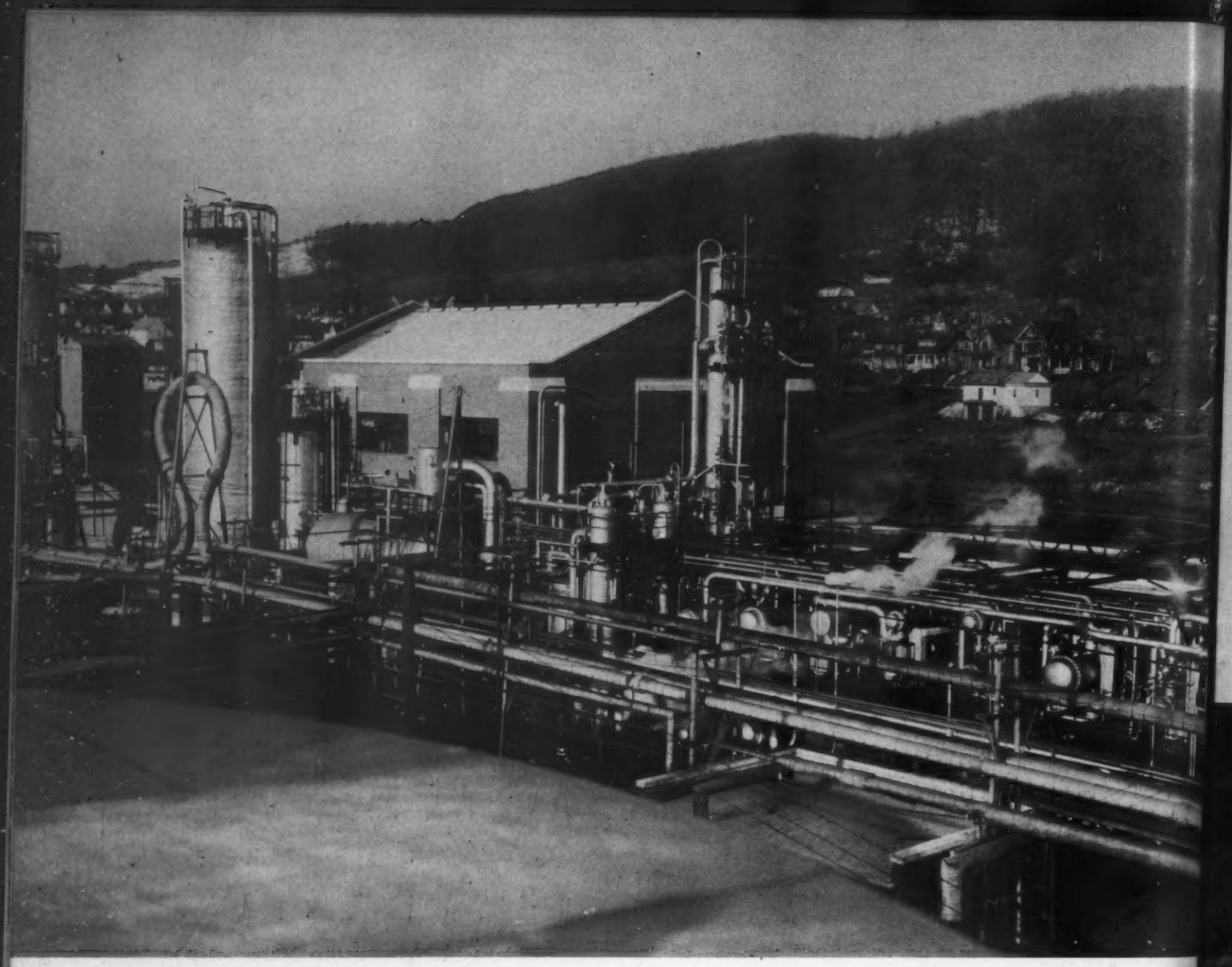
DURING the past fifteen years a number of changes have been taking place which have seriously affected the refiner of Pennsylvania crude. Most of these changes have resulted not from any action of the Pennsylvania refiner himself, but from developments in the petroleum industry outside the Pennsylvania field and from changes in design of automotive equipment in which most lubricating oil is used. Before discussing the application of propane processing to Pennsylvania oils, it is helpful to review briefly these changes in order to realize what is required to meet them and to understand the ways in which propane may be used to accomplish these results.

The first, and probably the most important, change that has taken place is the recognition of the high quality of Pennsylvania oil and the development of processes applicable to other and less expensive crudes which would enable them to approach this quality. Prior to 1925, petroleum technologists were in considerable disagreement as to the relative qualities of lubricating oils produced from crude oils from various sources. The consuming public, on the other hand, was apparently convinced that lubricating oils produced from Pennsylvania crude were premium products and were worthy of a reasonable price differential. During the period from 1925 to 1930, petroleum technologists came into fairly universal agreement that the lubricants produced from Pennsylvania crude were definitely superior to lubricating oils then being produced from most other crudes. Once such an agreement was reached, it was only a relatively short time until improved lubricants approaching Pennsylvania oil quality were being produced from inferior crude oils.

Many Pennsylvania refiners will remember the developments of the past two decades in which most light oil products from Pennsylvania crude, originally considered of superior quality, became strictly competitive with similar products from other crudes. During the last six to eight years they have seen a similar trend in the case of lubricating oils produced from Pennsylvania crude, and while the trend with lubricants will probably not continue to the point reached in the case of light oils, the latter serves as a parallel which the Pennsylvania refiner should keep in mind when considering future operations.

There can be no reasonable doubt but that some lubricating oils produced by modern refining methods from inferior crude sources have already approached conventional Pennsylvania quality. As a result of this change, the refiner of Pennsylvania crude is finding profitable marketing of his oils a greater problem.

The second important change has been in the increasing demand for lighter motor oils. Several years ago, the average oil used in motor cars was heavier than an S. A. E. 30 grade with relatively large consumption of the S. A. E. 40 grade. Over a period of only a few years the average viscosity requirement has decreased until it is now approaching the S. A. E. 20 grade with considerable demand for lighter oils. One way of visualizing this change is in the relative demands for 180 viscosity neutral and for 150 viscosity bright stock, which are the usual blending stocks in the Pennsylvania refinery. As late as 1932 the motor oils produced in one refinery required only 45 percent of neutrals while in 1937 they required 65 percent of neutrals. For every 100 units of neutral available in the crude the Pennsylvania refiner was able to utilize 122 units of bright stock in 1932 while in 1937 the same amount of neutral enabled him to dispose of only 54 units of bright stock in his blended motor oils. In other words, this change in motor oil requirements has reduced the bright stock utilization in motor oil blends by about 55 percent. From the same amount of crude processed, or for the same quantity of neutral and blended motor oils made, the amount of surplus bright



Propane Process, Kendall Refining Company, showing equipment arrangement. On opposite page is an air view of the plant.

stock has been greatly increased and now represents a very serious problem.

The third change which has been taking place, and which is still in progress, is in the motive power which uses the major portion of lubricating oils. Recent trends in automotive and aeronautic engines have placed internal combustion engine lubricants under a much more severe duty than has ever been imposed in the past. This trend cannot be offset entirely by improvement in engine design, since it is largely the result of producing a greater horsepower out-put from a given engine displacement, which naturally results in appreciably higher operating temperatures and pressures. For this reason, oils which were satisfactory for severe duty a few years ago are no longer entirely satisfactory for present day engines. The trend in engine manufacture at the present time seems to be to take maximum advantage of the highest lubricating oil quality which is available, so that motor oils which were entirely adequate a few years ago are now reaching the limits of their applicability. This limit may be in several characteristics, but the general tendency is to consider oxidation and sludge formation as extremely important factors, and also to consider many others which were not considered of serious consequence only a few years ago. This change has not greatly affected the Pennsylvania refiner so far, but it is one which he should evaluate thoroughly in planning for the future.

A consideration of these changes and their probable effects make it quite evident what the general corrective measures should be. If Pennsylvania refiners are to compete successfully with improved oils from lower cost crudes, they must be prepared either to offer equivalent quality at competitive prices or to justify a higher price by giving still better quality. To compete directly on an equal quality basis the Pennsylvania refiner must reduce his costs so as to offset the effect of his higher priced crude and the use of new and more economical methods by the refiners of other crudes, while to justify an appreciably higher price he must further improve the quality of Pennsylvania oil so as to reproduce the quality differential which previously existed. It is, of course, advisable to reduce costs in any event and it appears advantageous also to improve quality, since by so doing the Pennsylvania refiner would better the competitive situation and at the same time be able to meet the demand for improved oils which modern automotive engines require. In the same way that the Pennsylvania refiner

was previously fortunate in having an oil of natural high quality, he is now fortunate in being able to start his improvement at this high quality level and thus economically reach a level not readily equalled by refiners of inferior crudes.

The problem of meeting the present lower viscosity requirement is clearly one of reducing the average viscosity of the total lubricating oil fractions but with a minimum decrease in total production. The elimination of a small amount of very viscous material is obviously the most satisfactory method of obtaining a minimum viscosity with a maximum yield. Such a step will reduce the amount of bright stock and particularly the ratio of bright stock to equivalent neutral.

It thus appears that the changes in the competitive situation and in the viscosity and quality of the oils required will seriously interfere with the profitable manufacture and marketing of Pennsylvania lubricants unless the Pennsylvania refiner improves this situation in the following three major aspects:

(1) By producing oils of still higher quality.
(2) By increasing the amount of effective neutral made and thus decreasing the ratio of bright stock to neutrals.
(3) By reducing processing costs.

These factors were all considered by Kendall Refining Company when it decided to install a propane dewaxing and deresining plant in its refinery at Bradford, Pennsylvania, in 1936. Some of the results of the early operation of that plant have already been discussed in a previous publication[1] and it is the purpose of the present paper to show further how the use of propane processing has helped them to improve their situation.

IMPROVEMENT IN LUBRICATING OIL QUALITY

It has been previously stated that lubricating oils of improved quality from inferior crudes are available today which approach the quality of conventionally refined Pennsylvania lubricating oils. These oils of the present improved quality can be produced in many cases more cheaply from crude oil obtained from other areas than oils can be produced from Pennsylvania crude. The above statement is true, of course, largely because of the cost differential which exists between Pennsylvania and other lubricating oil crudes. Assuming that this differential will remain, it is important to find some way of correcting

[1] Refining of Pennsylvania Oils by Propane Process; McCluer, Dickinson and Forrest, Oil and Gas Journal, March 31, 1938.

this situation, even when the manufacturing cost is reduced to a minimum.

One such method would be to produce a still higher quality oil to give a greater safety factor in present engine design, and to permit even greater demand on the lubricant by future engine design. It is generally recognized that lubricants of even better quality than those now being used can be produced more economically from Pennsylvania crude than from other crude oils. This is true because the yield from other crude oils decreases very rapidly as the quality is improved above the present high quality range. Since Pennsylvania oils require only slight treatment

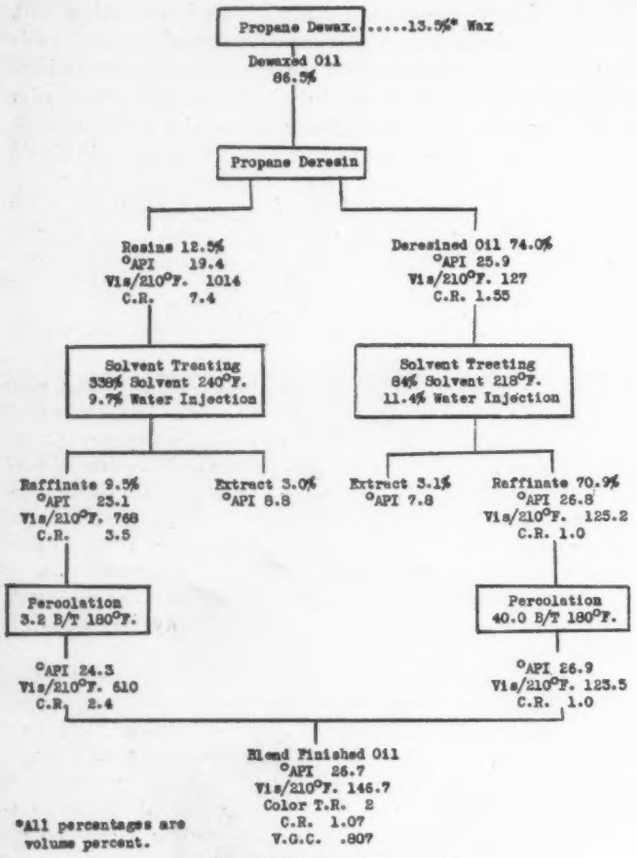


FIGURE 1

Processing Bradford Cylinder Stock.

to improve the quality, the decrease in yield is not such an important factor, and improved Pennsylvania oils should be able to justify a higher priced crude in the same way that they were able to do so when the quality differential was greater than at present.

The generally accepted method for improving the quality of Pennsylvania oils is solvent treatment, not only for increase in viscosity index, although that usually accompanies the treatment, but also for improvement in oxidation and sludging resistance and for reduction in carbon residue. It is not the purpose of this paper to compare the merits of the various solvent processes but only to indicate how propane processing may be utilized in conjunction with them. Because the value of propane in this connection is essentially restricted to residual oils, the discussion omits the question of solvent treating distillates, except as they might be included in long residuum refining operations.

The propane deresining process itself results in some improvement in quality because the heaviest ends of the cylinder stock are removed to produce a narrower cut bright stock. Elimination of the most undesirable heavy oil, and lowering the volatility and increasing the flash and fire points of the bright stock which results from this process, constitute improvements in quality. This improvement alone, however, is not all that is required to justify an appreciable premium for the bright stock.

The dewaxed and deresined oil from a propane plant may be treated directly with any desired selective solvent without loss of efficiency in the extraction process. There is really an advantage obtained by deresining in the case of single solvent treating because the removal of a small amount of resins gives a saving in decolorizing costs even when solvent treating is practiced.

More recently, it has been found that propane deresining has other advantages as a means of preparing residual stocks for efficient treatment with single solvents. It has been shown that a heavy resin fraction may be treated separately with a high solvent dosage and the less viscous deresined oil with a low solvent dosage, with a distinct advantage in both quality and yield as compared with treating the entire residuum as one fraction. The data presented in Figure 1 shows the results of separating the dewaxed oil into two fractions by deresining, treating and decolorizing each fraction separately, and blending the finished oils in the proportions in which they were produced. The 12.5 percent resin fraction, having a viscosity of 1014 S.S.U. at 210° F. was produced in commercial operation at the Kendall refinery and the deresined oil which was produced simultaneously had a viscosity of 127 S.S.U. at 210° F. and a color of about 7 N.P.A.

The resin fraction was treated in a laboratory countercurrent tower with 338 percent phenol and 9.7 percent water was injected at the bottom of the tower for refluxing. The raffinate from this process was 75.9 percent of the resin charge or 9.5 percent of the original cylinder stock. This raffinate had a viscosity of 768 S.S.U. at 210° F. and a carbon residue of 3.5. It was then percolated in naphtha solution through Attapulgus clay to a color of 1 T.R., or about 8 N.P.A., with a clay yield of 3.2 barrels per ton. The finished resins then had a viscosity of 610 S.S.U. at 210° F. and a carbon residue of 2.4. Although this is an unusual product itself, it is of particular advantage when blended with the separately treated and percolated deresined oil.

The deresined oil was treated with only 84 percent solvent as compared with the 338 percent used on the resins, and the yield was 95.8 percent based on the charge, or 70.9 percent of the original cylinder stock. The viscosity was reduced only slightly (to 125.2 S.S.U. at 210° F.), while the carbon residue was reduced to 0.96. This raffinate was then percolated through Attapulgus clay with a yield of 40 barrels per ton, to give a color of 2¼ T.R., or about 6 N.P.A., and essentially no change in carbon residue.

When these two percolated oils were blended in the proportions in which they were produced, the resulting oil corresponded to 80.4 percent of the cylinder stock, the dewaxing loss having been 13.5 percent and the loss to extract by solvent treating 6.1 percent. The finished oil had a carbon residue of 1.07, which is less than 0.75 percent of the viscosity at 210° F., and the V.G.A. was 0.807. It is particularly

noteworthy that the heaviest 12 percent of the finished cylinder stock has a low carbon residue for the viscosity and a viscosity-gravity constant which is better than that of the main portion of the bright stock.

Adoption of propane deresining followed by solvent treating thus permits any degree of refinement on the heavy and lighter fractions of the bright stock. For example, the propane deresining step may be carried out to produce only 3 to 5 percent of resins and the deresined oil may be finished by percolation alone as is the usual practice at the Kendall refinery. On the opposite end of the scale, it has been demonstrated by pilot-plant operations that it is possible

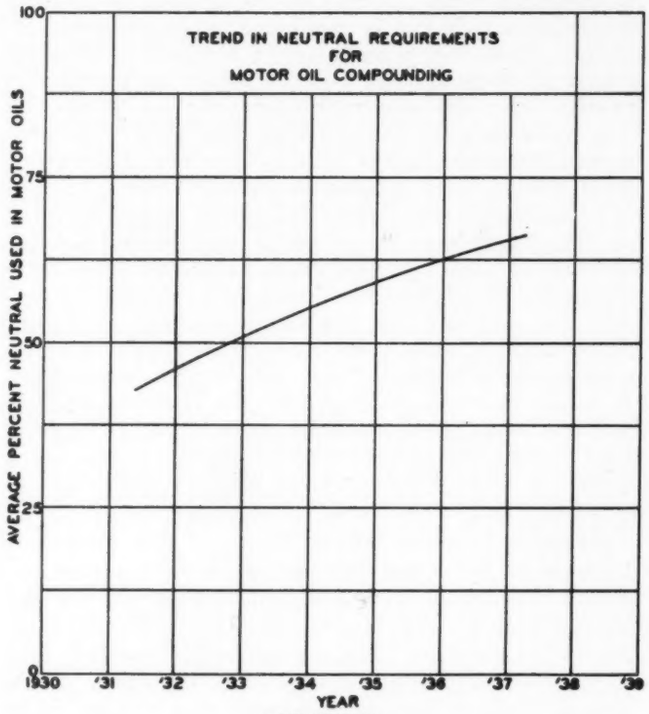


FIGURE 2

to precipitate as much as 30 to 40 percent of resins and treat them with a large quantity of solvent, while the deresined oil simultaneously produced may be used directly or may also be solvent treated to any desired degree. Between these limits a wide variety of combinations are possible which permit the refiner to take care of market demands and fluctuations in crude and product prices.

Propane deresining, therefore, does give improvement in some characteristics, and also serves as a means of preparing residual stocks for most efficient treatment with selective single solvents.

REDUCTION IN VISCOSITY (BRIGHT STOCK-NEUTRAL RATIO)

The yield of neutral and bright stock obtained from Pennsylvania crude oil depends to a considerable extent on the particular area from which the crude is obtained, on the specifications of the finished product, and on the refining methods employed. It is probable that the average yields of neutral and bright stock obtained from Pennsylvania crude oil are approximately 6 to 7 percent and 15 to 17 percent respectively. In general the ratio of bright stock to neutral is about 2.5 to 1, or to state it differently, the neutral is about 29 percent of the total lubricating oil produced from Pennsylvania crudes.

As pointed out previously, there has been a gradual decrease in the average viscosity of lubricants required for automotive engines. Considered from the viewpoint of neutral requirement, this trend is shown graphically in Figure 2. The increase in neutral requirement from 45 percent of the motor oil blends in 1932 to 65 percent in 1937 is of even greater significance than these figures would imply at first glance. The limitation in crude refining or production capacity, or both, may prevent a refiner from marketing as much blended motor oil as he might wish. For example, a refiner processing 5000 barrels per day of crude could finish about 300 barrels of neutrals or about 650 barrels of blended motor oils on the basis of the 1932 average viscosity. In 1937, however, the amount of neutral produced remaining the same, he could make only 460 barrels of blended motor oils, and would have 590 barrels of surplus bright stock as compared with a surplus of only 400 barrels in 1932. Surplus bright stock, over and above the amount that can be blended with Pennsylvania neutral for average motor oil requirements, now amounts to 80 percent of the Pennsylvania bright stock that could be produced, or about 12 percent of the total Pennsylvania crude processed.

The above facts indicate that the Pennsylvania refiner has a distinct need for processing methods which will permit him to produce larger quantities of neutral, or the equivalent, from the crude and at the same time reduce the quantity of bright stock. The present and relatively nonflexible yields which are obtained by conventional refining methods frequently result in the building up of huge bright stock inventories because the demand for neutral and lighter products dictates the quantity of crude run to stills. High stock inventories and reasonable margins of profit for refining do not generally go hand in hand.

Larger quantities of neutral or distillate stocks may be obtained from the crude, of course, simply by distilling to higher viscosity cylinder stocks. This procedure, however, is not beneficial unless these heavier cylinder stocks can be finished to the normal 150 viscosity bright stock. If the viscosity of the heavier cylinder stock is not reduced in finishing there would be no net gain in neutral equivalent because all of the intermediate distillate would be required to adjust the bright stock viscosity. This distillation step would not be without complication because some type of solvent dewaxing process probably would be required to dewax the intermediate distillates.

Presumably two methods are available for producing 150 viscosity bright stock from higher viscosity cylinder stocks without resorting to thermal decomposition. Theses methods are: (1) Vacuum distillation (or its equivalent) where an overhead cylinder stock and very high viscosity fuel oil bottoms would be obtained, and (2) Propane deresining where 150 viscosity residual stock would be produced before or after dewaxing the high viscosity cylinder stock. Insofar as it is known, no distillation process has been developed which is entirely satisfactory from yield and economic viewpoints when reducing Pennsylvania residuum to less than 1 percent of the crude. Propane deresining, on the other hand (especially if used in conjunction with propane dewaxing), has been shown to be satisfactory from both yield and economic viewpoints.

The propane dewaxing and deresining plant of Kendall Refining Company originally was operated

on a cylinder stock having a viscosity of about 165 S. S. U. at 210° F., with the removal of about 3 to 5 percent of very heavy resins having a viscosity of 3,000 to 4,000 S. S. U. at 210° F. Removal of this quantity of very viscous material (about 0.5 to 0.9 percent based on crude) increases the equivalent neutral much more than the same amount, and has a rather surprising effect on the surplus bright stock.

In the first place, distillation of the crude to 165 viscosity instead of the normal 145 viscosity gives an intermediate waxy distillate cut amounting to 2.2 percent of the crude. Approximately 85 percent of this fraction is then obtained as zero pour test distillate after propane dewaxing, with a viscosity of 53 S. S. U. at 210° F. This represents an increase of dewaxed distillate yield of 1.87 percent based on crude which is about 30 percent of the usual neutral production. Since this oil is slightly heavier than neutral, it cannot all be considered as a net gain, but it can be assumed to be a blend of 77 percent of 180 viscosity neutral and 23 percent of 150 viscosity bright stock, so that its neutral content is 1.43 percent of the crude and its bright stock content is 0.44 percent of crude. By distillation to 165 viscosity at 210° F., the cylinder stock was reduced from 19.5 to 17.3 percent of crude and the actual bright stock was reduced from 16.0 percent to 13.7 percent of crude by the combined effects of distillation and deresining. This method of processing, which was the one originally adopted by Kendall Refining Company, increased the equivalent 180 viscosity neutral by 25 percent and decreased the total bright stock by 12 percent below that which would have been obtained by propane dewaxing alone without deresining. Actually the yield of total bright stock, including that in the intermediate distillate, remained almost constant as compared with conventional processing, because the increased dewaxing yield by propane dewaxing compensates for the lesser amount of cylinder stock made as well as for the removal of the very viscous resin fraction. Instead of a surplus bright stock of 80 percent or more by conventional processing or by propane dewaxing without deresining, the surplus bright stock by this process is only 61 percent.

Although the above operation represents a significant improvement in the ratio of neutral to bright stock, the method has been carried even further in more recent plant operations. The distillation step has been operated to produce 15.4 percent of a 190 viscosity cylinder stock and 4.1 percent of intermediate distillate which has a viscosity of 58 S. S. U. at 210° F. after dewaxing to zero pour test with a yield of about 85 percent. This distillate may be considered as 67 percent neutral and 33 percent of 150 viscosity bright stock, and the net increase in neutral yield is therefore 2.4 percent of the crude or 40 percent of the neutral from operation without deresining. At the same time the actual bright stock has been reduced from 16.0 percent without deresining to 11.7 percent of the crude and the total bright stock equivalent is 12.8 percent of the crude. The neutral equivalent is thus increased by 40 percent and the bright stock is reduced by 19 percent from that obtained without deresining or by only 11 percent from that obtained by previous processing methods. The surplus bright stock has been reduced from about 12 percent to slightly more than 8 percent of crude.

These results have been obtained when operating the propane dewaxing and deresining plant on the residual stocks of the above viscosities. No difficulties have been encountered in dewaxing and deresining any of the cylinder stocks which have been used, covering the range from 150 viscosity to 190 viscosity at 210° F. and pour tests from 0°F. to +20° F. Obviously, the yield of dewaxed and deresined oil decreases as the viscosity of the charge increases, because the high viscosity fraction must be increased to maintain a constant product viscosity of 150 S. S. U. at 210° F.

A comparison of the results of these methods of operation with those obtained by conventional processes is presented in Table 1. In all cases the actual 180 viscosity neutral remains constant at 6.0 percent of the crude, but as the viscosity of the cylinder stock is increased from 145 to 190 the amount of blended motor oil which can be produced from the crude increases from 9.2 percent to 12.9 percent. This increase of 40 percent in blended motor oil production results from the elimination of only 1.4 percent of the crude as very viscous material. This represents a net fuel production of only 0.8 percent of the crude when taking filter losses into consideration.

The effect of propane dewaxing and deresining on the distribution of products from the lubricating fraction of Pennsylvania crude is shown even more strikingly in Figure 3. Although the actual neutral remains constant, the equivalent neutral, above the dotted line, gradually increases from zero to 2.4 percent as the viscosity of the cylinder stock increases from 145 to 190 S. S. U. at 210° F. The actual bright stock is decreased from 16.0 percent to 11.7 percent by the removal of intermediate distillate and heavy fractions, while the equivalent bright stock decreases from 16.0 to 12.8 percent.

In order to show the net result of this method of processing, the total amount of blended motor oils which can be produced is represented by the distance above the dividing line between the shaded and unshaded portions. The excess bright stock is indicated by the height of the shaded portion of the figure. This shows quite clearly that excess bright stock decreases much more rapidly than the loss to heavy products increases. Over this entire range the

TABLE 1

Effect of Processing Methods on Distribution of Products

	Using Conventional Methods	Using Propane Dewaxing	Using Propane Dewaxing and Deresining	
Vis. at 210 °F. of cylinder stock	145	145	165	190
Cylinder stock—% of Crude	19.5	19.5	17.3	15.4
Zero Pour Cylinder stock—% of Crude	15.3	16.6	14.7	13.1
Resins removed—% of Crude	....	....	0.7	1.4
Filtering loss—% of Crude	0.8	0.6	0.3	0.0
Finished 150 Vis. Brt. Stk.—% of Crude	14.5	16.0	13.7	11.7
Zero Pour 180 Vis. Neutral—% of Crude	6.0	6.0	6.0	6.0
Intermediate Waxy Distillate—% of Crude	....	....	2.2	4.1
Intermediate Zero Pour Distillate—% of Crude	....	....	1.9	3.5
180 Neutral Equivalent of Intermediate Distillate—% of Crude	....	....	1.4	2.4
150 Vis. Bright Stock Equivalent of Intermediate Dist.—% of Crude	....	....	0.5	1.1
Total 180 Neutral or equivalent—% of Crude	6.0	6.0	7.4	8.4
Total 150 Bright Stock or Equivalent—% of Crude	14.5	16.0	14.1	12.8
Total Lube made—% of Crude	20.5	22.0	21.6	21.2
Bright Stock blended for Motor Oils—% of Crude	3.2	3.2	4.0	4.5
Total blended Motor Oils—% of Crude	9.2	9.2	11.5	12.9
Bright Stock-Neutral Ratio	2.42	2.67	1.90	1.53
Surplus Bright Stock—% of Crude	11.3	12.8	10.1	8.3

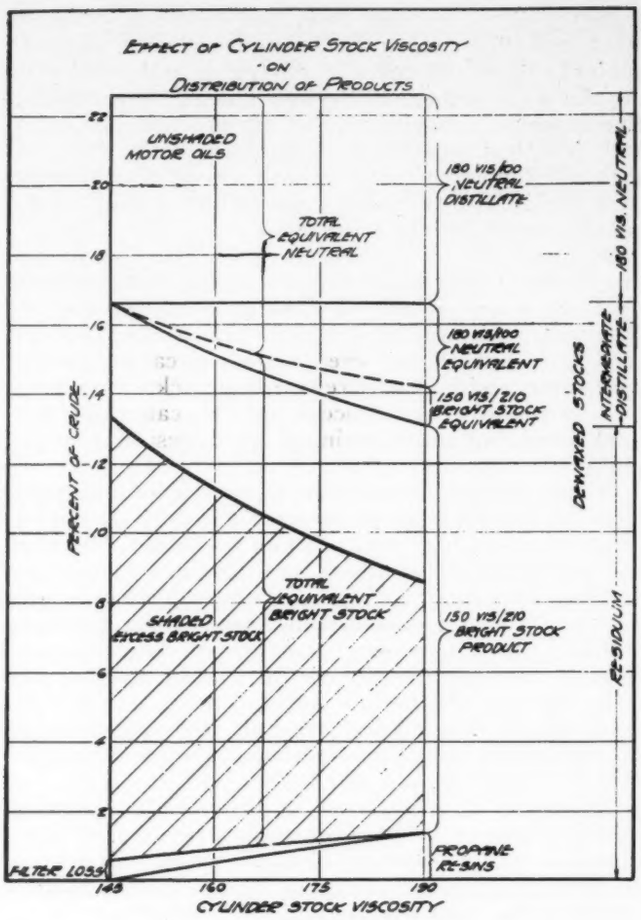


FIGURE 3

net increase in fuel is only 0.8 percent of crude, but the decrease in excess bright stock is 4.5 percent of crude and the increase in blended motor oil is 3.7 percent of crude.

These results may be presented still differently as in Figure 4, in which the ratio of finished bright stock to finished neutral is shown as a function of the viscosity of the residual stock charged to the propane dewaxing and deresining plant. The ratio as shown here is based on including the equivalent amount of bright stock and neutral which is present in the intermediate distillates. In the conventional processing of Bradford crude the ratio of bright stock to neutral was approximately 2.5 to 1 as shown in Table 1, while with propane dewaxing without deresining the ratio was 2.7 to 1. As the viscosity of the residual stock increased, the ratio decreased until it reached 1.5 to 1 at the maximum viscosity thus far used commercially, of 190 S. S. U. at 210° F.

One point, which may not be clear from the above discussion, is that the total lubricating oil yield is actually higher by this procedure than with the conventional process. For example, the total lubricating oil previously made was about 20.5 percent of crude, 14.5 percent of which was bright stock. Even when the viscosity of the residuum charged to the propane dewaxing plant was 190 S. S. U. at 210° F., the total lubricating oil produced was 21.2 percent or an increase of 0.7 percent in spite of discarding a portion of the crude (about 1.4 percent) as very viscous resins. This increase is of course due to the higher dewaxing yields and lower decolorizing loss, which more than offset the 1.4 percent of the crude discarded. The net result of propane dewaxing and propane deresining is thus to increase the yield and decrease the average viscosity of the oils produced.

Although the method outlined above is now being used by Kendall Refining Company and represents a very satisfactory procedure for improving the ratio of bright stock to neutral, it is not the only way of accomplishing this result. Actually the amount of neutral in the crude is not increased by this process, and all improvement in the bright stock to neutral ratio is obtained by reducing the quantity of bright stock. Distillation to a more viscous residuum and processing of the stock to finish at 150 viscosity reduces the actual quantity of bright stock but increases the neutral equivalent only because the light fraction of the cylinder stock which would be required to bring the heavy resin fraction to 150 viscosity may now be removed from the bright stock and used separately or as a blending stock. In other words, discarding of a very viscous fraction releases the amount of neutral which would be required for blending with this fraction to obtain the usual bright stock viscosity of 150 S. S. U. at 210° F.

The same result, insofar as bright stock to neutral ratio is concerned, may be obtained by another method of operation employed by Kendall Refining Company and described in the previous paper. In this case the 157 viscosity cylinder stock was dewaxed and then deresined to remove 13 percent of heavy oil having a viscosity of 1151 S. S. U. at 210° F. The deresined oil in this case had a viscosity of 117 S. S. U. at 210° F. and represented 13.5 percent of crude. When the plant was operated on the same charge stock to precipitate only 3.5 percent of resins, the viscosity of the bright stock was 148 S. S. U. at 210° F. and it represented 15.3 percent of the crude. The amount of 180 viscosity neutral required to bring the 148 viscosity stock to the average motor oil viscosity of 60 S. S. U. at 210° F. is 64 percent of the blend, while to bring the 117 viscosity stock to the same viscosity blend the neutral required is only 58 percent. The 6 percent of neutral available in the crude could therefore be used to blend with 4.4

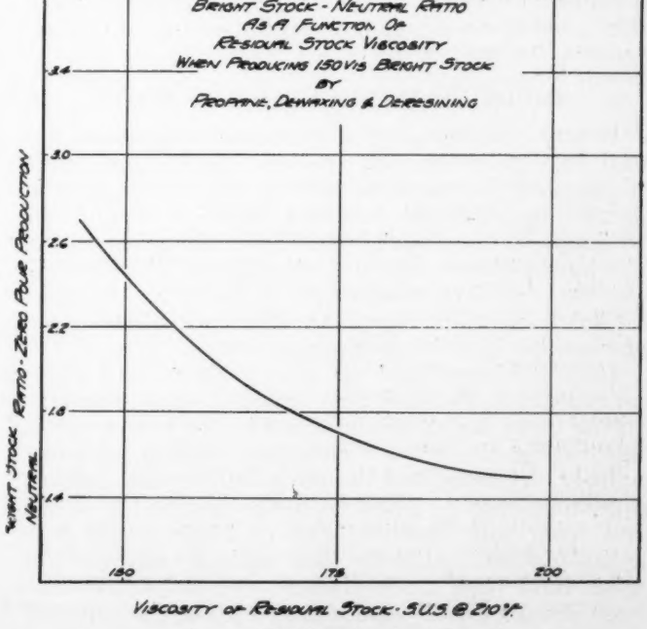

BRIGHT STOCK - NEUTRAL RATIO
AS A FUNCTION OF
RESIDUAL STOCK VISCOSITY
WHEN PRODUCING 150 VIS BRIGHT STOCK
BY
PROPANE, DEWAXING & DERESINING
BRIGHT STOCK RATIO - ZERO POUR PRODUCTION
NEUTRAL
VISCOSITY OF RESIDUAL STOCK - S.U.S. @ 210°F.

FIGURE 4

percent of 117 viscosity bright stock instead of only 3.4 percent in the case of 148 viscosity bright stock. By this method, therefore, the blended motor oil is increased from 9.4 percent to 10.4 percent by the elimination of an additional 1.8 percent of the crude processed in this manner. Since only 6.0 percent of cylinder stock would be required to produce the 4.4 percent of low viscosity bright stock for blending, the average amount of additional resins is only 0.6 percent. The same general result is thus accomplished by this method of operation as when distillation to heavier cylinder stock is resorted to, although in the present case a portion of the gain is a result of reducing the quantity of bright stock and another portion is the result of the lower viscosity of the bright stock produced.

Of course it would not be possible to process all of the residual stock by this latter process, unless the excess 117 viscosity bright stock could be readily marketed. It is possible, however, to so process the bright stock used for blending purposes in the refinery, and to process surplus cylinder stock to produce a marketable 150 viscosity bright stock while still taking advantage of deresining to reduce filtration costs on the latter stock. The net effect on bright stock to neutral ratio of producing a portion of the bright stock at low viscosity and a portion at normal viscosity would be essentially the same as for the method now employed by Kendall Refining Company of distilling a portion of the cylinder stock and processing the heavier residuum.

The above indicated processing methods might not always prove economically desirable when bright stock is in great demand, unless reasonably valuable by-products could be obtained from the operations when a large amount of resins is produced. Plant operations have shown that the resins which have been produced by these processes may be converted to high-viscosity specialty products by relatively minor changes which have now been made in the deresining portion of the plant. When the very high viscosity products are marketable as such, these operations are highly advantageous irrespective of the crude and product price structure. Even when the heavy products must be discarded as fuel, it is always possible to vary the amount of precipitation to maintain conditions which are optimum for any given economic situation.

REDUCING MANUFACTURING COSTS

In any consideration of manufacturing costs, it is desirable to confine the analysis within close limits to simplify comparisons insofar as possible without sacrificing accuracy. For this reason, it is advisable to compare the relative costs of producing lubricating oils by the older conventional methods with those by the more modern refining processes, after the crude oil has been subjected to its primary distillation and segregated into its component parts.

It should be pointed out that, in the case of almost all refiners of Pennsylvania crude, the only manufacturing costs which are involved in the production of lubricating oils are for two fundamental purposes; namely, dewaxing and decolorizing. Several different operations may be involved in the production of neutral from wax distillate and of bright stock from cylinder stock, but in the final analysis only two purposes have been accomplished—the raw stocks have been dewaxed and decolorized. Hence, the price differentials which exist between waxy neutral and dewaxed neutral, in one case, and between cylinder stock and bright stock, in the other case, are dependent only upon the costs of dewaxing and decolorizing the waxy neutral and cylinder stock, respectively. Fundamental consideration of the propane processes and practical operating experience with them at Kendall Refining Company have shown conclusively that significant reductions in manufacturing costs can be made by their use.

Propane can be applied by the Pennsylvania refiner to the reduction of manufacturing costs in three different ways. It can be used as a solvent and refrigerant for dewaxing distillate and residual stocks without deresining; it can be used as a solvent for deresining residual stocks before or after dewaxing by any process; or it can be used for carrying out both dewaxing and deresining operations in a single plant.

In considering the manufacturing cost for dewaxing alone, it is important to evaluate not only the major items of operating cost, utilities and labor, but also the increased yields which are obtained in the dewaxing operation and any changes which might affect subsequent decolorizing costs. The refiner installing a new dewaxing plant today should expect to make savings by reducing the cost of utilities and labor, by securing higher yields of dewaxed oil, and, if he selects propane dewaxing, by reducing the cost of subsequent decolorizing because propane has the ability to precipitate color bodies with the wax.

Operating data obtained at the Kendall refinery indicate that if propane dewaxing alone had been installed, the economies effected would have been sufficient to pay for the plant in approximately two years. Since increased yields and reduced operating costs alone would have permitted paying for the plant in about 2.6 years the difference shows the value of the decolorizing which accompanies propane dewaxing.

Uniform plant operation and consistently high yields are essential factors in manufacturing cost in any plant which is installed to serve a definite economic function. Daily throughput obtained in the propane dewaxing and deresining plant of Kendall Refining Company during the first 6 months of 1938 are contained in Figure 5. These data show that, even through the plant charged a variety of different stocks, frequently for short periods, the throughput was essentially constant, the average capacity during the first 6 months of 1938 being 1,053 barrels per stream day. During the past two months the plant has been operated on both distillates and residual stocks at throughputs which are 15 to 20 percent higher than this average.

The dewaxing and deresining yields obtained dur-

TABLE 2
Yields Obtained With Various Stocks
(Six Months Totals)

	Cylinder Stock—165 Vis. at 210 °F.			Heavy Neutral	Light Neutral
	Zero Pour		+20 °F. Pour	Zero Pour	Zero Pour
	125 Vis.	150 Vis.	150 Vis.		
Stock Charged, barrels	12,676	45,837	59,872	14,864	37,727
Dewaxed Oil, barrels	10,717	39,180	54,218	12,558	31,089
Percent	84.6	85.5	90.5	84.5	82.4
Dewaxed & Deresined Oil bbls.	8,797	36,647	51,152	.....	.....
Percent	69.4	80.0	85.4	.....	.....
Petrolatum or Wax, barrels	1,959	6,657	5,654	2,306	6,638
Percent	15.4	14.5	9.5	15.5	17.6
Resins, barrels	1,920	2,533	3,066	.....	.....
Percent	15.2	5.5	5.1	.....	.....

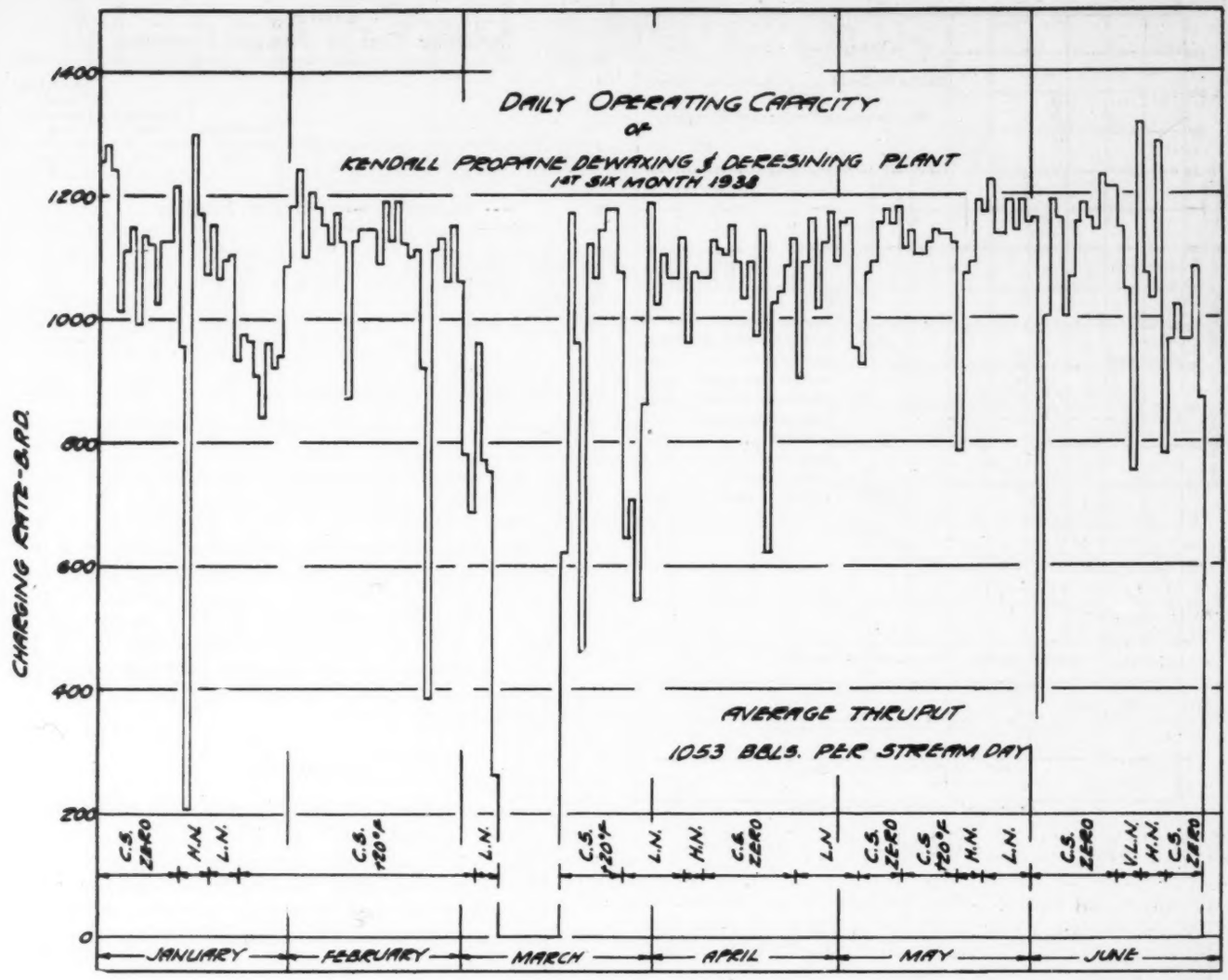


FIGURE 5

ing the first 6 months of 1938 are shown in Table 2.

The flexibility of the propane dewaxing process, as shown by the capacity and yield data on various stocks, is an important item in manufacturing cost. Most of the yield and operating cost savings which may be credited to the new dewaxing processes for Pennsylvania oils result from improved operation on residual stocks. However, the consolidation of distillate and residual dewaxing plants in one unit results in quite definite savings in labor and maintenance and in fixed costs.

The ability of the propane dewaxing process to precipitate a portion of the coloring matter from the oil and reduce the decolorizing cost by about 30 percent results in a reduction of the pay-off time for a 1,000-barrel plant from about 2.6 to 2 years. Addition of a deresining step still further reduces this pay-off time by greatly reducing clay requirement with only a small decrease in finished oil production. Precipitation of about 4 percent of resins increases the percolation yield by approximately 100 percent and decreases the decolorizing cost proportionately.

Using the operations of the present plant as a basis it has been estimated that a propane deresining plant (without dewaxing) for handling 1,000 barrels of cylinder stock per day would show a pay-off period of about 1.8 years as a result of savings in the cost of decolorizing by removing about 4 percent of resins. These resins cannot be debited against the process because experience has shown that a large part of the material removed by deresining would normally have been taken out by the decolorizing step. A deresining plant could precipitate much more of the cylinder stock without appreciable increase in cost, but when the resin fraction amounts to more than 6 percent the savings in clay alone will not always pay for the decrease in finished oil.

This point is shown by the operations to produce 13 percent of resins, where the clay consumption was only 20 percent of the requirement when using conventional dewaxing. Where the removal of 4 percent resins reduced the clay consumption by 50 percent, the removal of the additional 9 percent reduced it only 30 percent with a net saving of only about $0.35 per barrel and a net decrease of nearly 4 gallons of finished bright stock per barrel of charge. Obviously, if finished bright stock has a differential value of $0.15 per gallon, this operation must depend on production of materials other than fuel from the resins, or on the increase in neutral equivalent. On the other hand, if the differential value is only $0.06 per gallon, the operation is economically justified even if the resins are discarded as fuel, and the increased neutral equivalent is an added advantage.

Although either a propane dewaxing plant or a

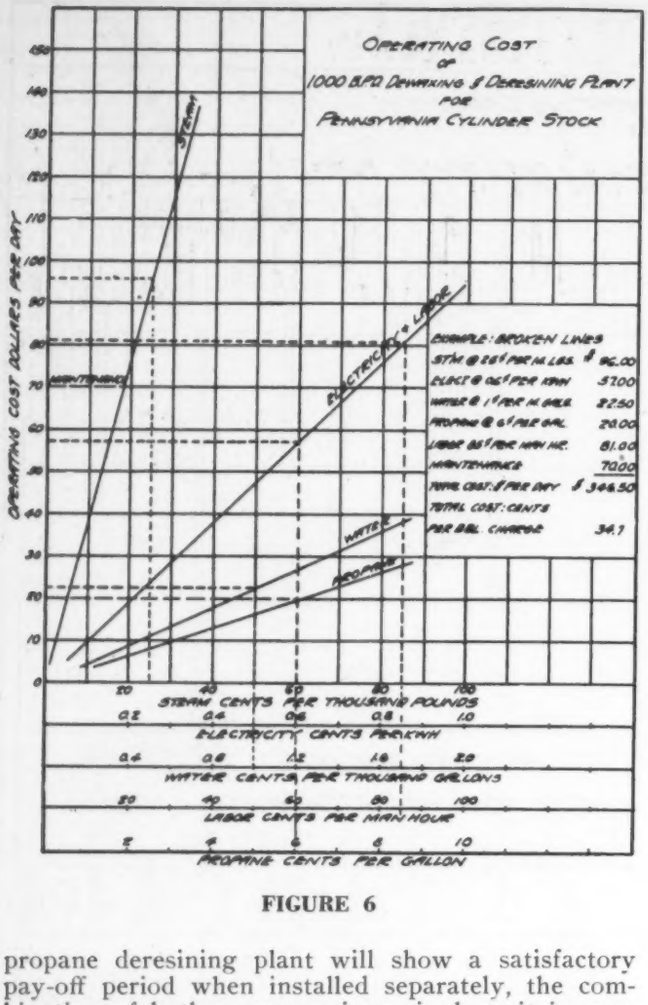


FIGURE 6

propane deresining plant will show a satisfactory pay-off period when installed separately, the combination of both processes in a single unit is even more attractive. The operations over the past 18 months show that the economies effected by installation of a combined plant to charge 1,000 barrels per day result in a pay-off period of about 20 months. A comparison of the operating costs for a plant to dewax 1,000 barrels per day of cylinder stock, and deresin the dewaxed oil, with corresponding costs for the separate plants, is shown in Table 3. The difference in the costs is about $0.13 per barrel of cylinder stock or about $45,000 per year in favor of the combined plant, and the installation cost for the combined plant would be about $100,000 lower than for the separate plants.

Obviously, all refiners of Pennsylvania oils will not have the same costs for utilities and labor, and for this reason the accompanying chart, Figure 6, has been prepared so that each refiner can estimate, for his own conditions, the approximate operating cost when employing propane to dewax and deresin Pennsylvania cylinder stock. The example chosen on this chart is based on one particular set of unit costs but a refiner may substitute his own costs to determine an approximate total operating cost. Actual design for any given situation might change the relative proportion of various items in order to arrive at a minimum cost, so that such figures cannot be considered as final.

TABLE 3
Operating Cost of Propane Processing

	Dewaxing	Deresining	Dewaxing and Deresining
Charge Capacity, B.P.D.	1,000	850	1,000
Operating Cost: Dollars Per Day			
Steam @ 25¢/M. Lbs.	$64.00	$81.50	$96.00
Electricity @ 0.6¢/KWH	62.00	2.50	57.00
Water @ 1¢/M. Gals.	20.00	14.50	22.50
Propane @ 6¢/Gal.	14.00	15.50	20.00
Labor @ 85¢ per Man Hour	81.00	41.50	81.00
Maintenance @ 3%	60.00	20.00	70.00
	$301.00	$175.50	$346.50
Cost—Cents per Barrel Charge	30.1	20.6	34.7
Cost—Cents per Barrel Cylinder Stock	30.1	17.6	34.7

The economic advantages of propane processes in other refineries would not necessarily be the same as for the conditions at Kendall Refining Company since the relative importance of dewaxing and decolorizing costs may vary to some extent. It has been shown, however, that propane dewaxing and propane deresining will bring about a reduction in the cost of both of these operations and it can be expected that savings will be made in other refineries comparable with those which have been made by Kendall Refining Company.

SUMMARY

The facts presented in this paper may be summarized as follows:

(1) The status of the Pennsylvania refiner as a manufacturer and marketer of lubricating oils has been appreciably changed during the past few years by events which include: (a) Competition of improved oils produced from lower cost crudes, (b) Reduction in the average viscosity required for automotive oils with a resultant greater surplus of bright stock, and (c) Demand for lubricants of still higher quality brought about by the use of more severe engine conditions.

(2) To combat these changed conditions, it appears that the Pennsylvania refiner should make changes in his refining methods which will improve the quality of lubricants produced, increase the quantity of neutral equivalent obtained from the crude, and decrease manufacturing costs.

(3) Commercial operating results have been presented which shows that the use of propane processing methods will reduce manufacture costs, increase the amount of blended motor oils which can be made and correspondingly decrease the surplus bright stock, while at the same time giving an increase in the overall yield of lubricants and some improvement in the quality of the bright stock and serving as a means of preparing residual stocks for most efficient treatment with selective single solvents.

Motor Fuel Demands

On the Petroleum Industry by the Modern Automobile Engine

By W. W. SCHEUMANN
Cities Service Oil Company

Delivered before Regional Technical meeting of the Western Petroleum Refiners Association, Shreveport, Louisiana.

THERE exists today a general realization that the continued development of improved automobile engines and fuel systems, and improved fuels and lubricants, is an interrelated problem, which demands continued cooperative effort on the part of the automotive and petroleum industries for further progress. A review of the developments made in this field during the last decade indicates many cases of splendid cooperation, but it also points out numerous instances where this spirit of cooperation was lacking. Changes and innovations have been introduced by the automotive industry without previous advice to the petroleum industry and, as a result, the refiner in numerous instances has had to develop products, on very short notice, to meet resulting requirements. Fortunately this has applied chiefly to special products such as free wheeling lubricants, hypoid lubricants, and the like, and not to major products such as motor fuels or motor lubricants.

Changes in automobile motors affecting fuels or lubricants have been in accordance with a definite trend, and as a result the petroleum industry has had a fairly definite realization of the direction in which it should move with reference to its research and development work on these products. Even in the case of motor fuels, however, the refiner feels that he has been in an unsatisfactory position, as requirements have steadily increased which, in turn, have increased his operating expenses and caused rapid obsolescence of his equipment. At the same time, automobile fuel systems have imposed restrictions which have been a definite handicap as they do not permit him to take fullest advantage of his production of light hydrocarbons.

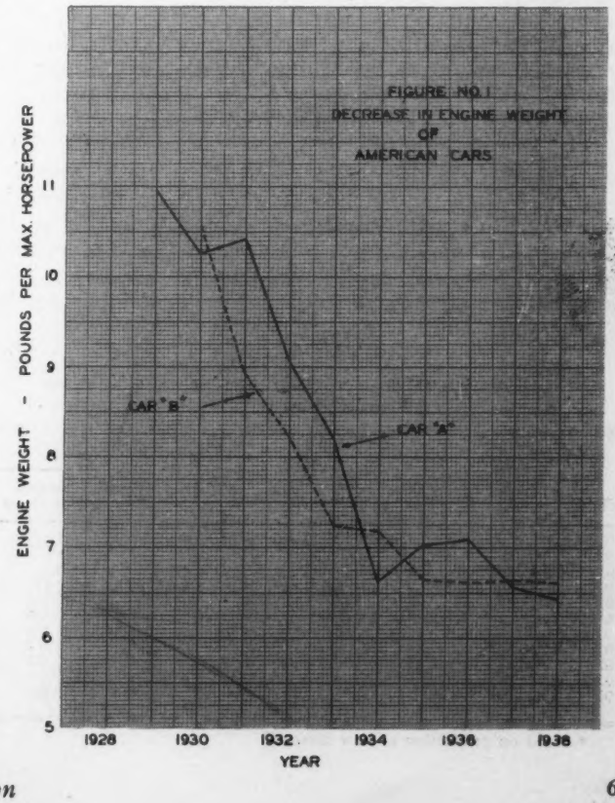
A further complication of the problem is due to the unsatisfactory economic conditions and motor fuel price structures, which in many cases do not adequately repay the refiner for the added expenses required to produce fuels of the necessary qualities or, at least, give little justification for the installation of newer equipment or processes, except on the basis of reduced manufacturing expenses.

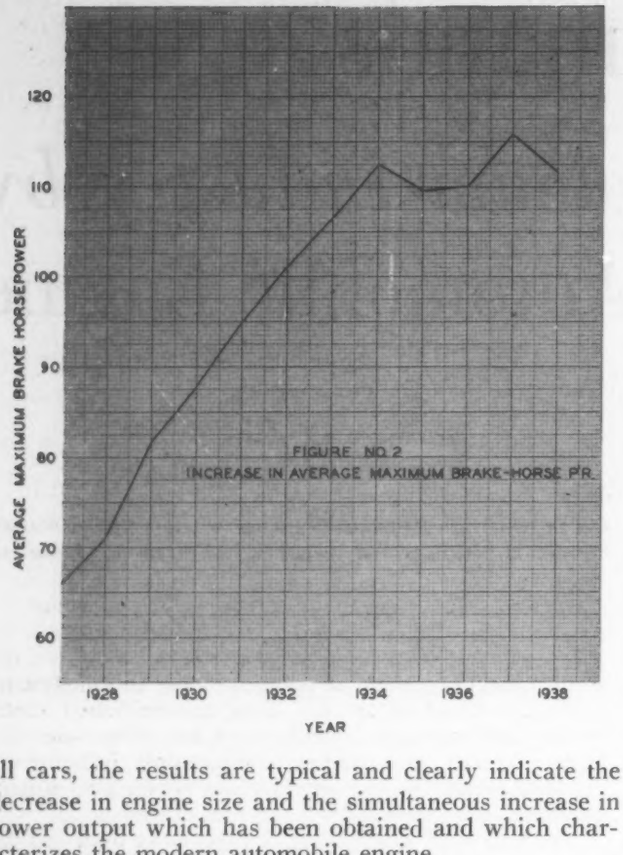
CHANGES IN AUTOMOBILE ENGINES

Competition in the automobile industry has demanded that the automobile builder continually improve his yearly models. These improvements have pertained to all features but have been particularly emphasized in the performance characteristics of the automobile. Limiting this discussion to the power plant, the improvements made have been actuated by the desire to produce an engine having the ultimate in smoothness of operation, and which would give more performance and better economy for a given size and weight. Many factors have contributed to the accomplishment of this result; however, without going into the thermodynamic principles involved, it has been accomplished chiefly by building engines of smaller size, but which operate at higher speeds and higher compression pressures to produce greater power output, show better performance characteristics, and higher thermal efficiency.

The extent to which these changes have occurred over a period of 10 years is shown in the following charts, which are based on averages calculated from the yearly number of models offered by all American automobile builders.[1]

Figure 1 shows the change in engine weight per maximum brake horsepower, over a period of years for two typical, popular priced American automobiles.[2] While the numerical figures may not be an average of





all cars, the results are typical and clearly indicate the decrease in engine size and the simultaneous increase in power output which has been obtained and which characterizes the modern automobile engine.

Figure 2 shows how greatly the power output of automobile engines has been increased since 1927. In Figures 3 and 4 is shown the corresponding increases in engine speed and compression ratios respectively, and which explains how the previously mentioned increased power output has been obtained.

Figure 5 shows the increase in the average Brake Mean Effective Pressure and indicates more correctly the higher average cylinder pressures encountered in the modern automobile engine than does the compression ratio increase, as it includes such factors as valve timing, volumetric efficiency, and other engine design factors which relate to the absolute pressures during operation.

These changes in engines are responsible for improved performance, power and efficiency. They also, to some extent, are responsible for the improved smoothness of the modern engine. Another factor, however, is also partially responsible for this characteristic, namely the use of a number of cylinders, in the engine, and therefore a smoother flow of power impulses. The extent to which this change has occurred is shown in Table 1.

TABLE 1

Classification of Automobile Engines By Number of Cylinders*

YEAR	PERCENT			
	Four	Six	Eight	Twelve and More
1927	49.7	47.1	3.2	....
1928	50.7	45.0	4.3	....
1929	40.7	54.3	5.0	....
1930	44.5	43.6	11.8	0.1
1931	33.3	52.0	14.5	0.2
1932	17.9	50.4	31.1	0.6
1933	3.2	61.8	34.7	0.3
1934	1.2	59.8	38.8	0.2
1935	0.5	59.6	39.4	0.2
1936	0.5	66.5	32.4	0.6
1937	1.5	63.5	34.2	0.8

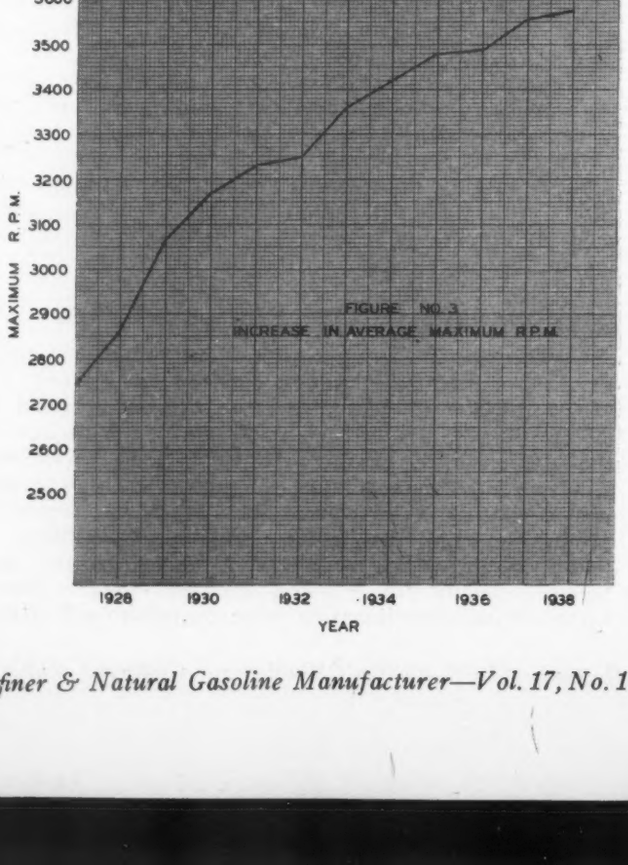
* Based on production of new cars.

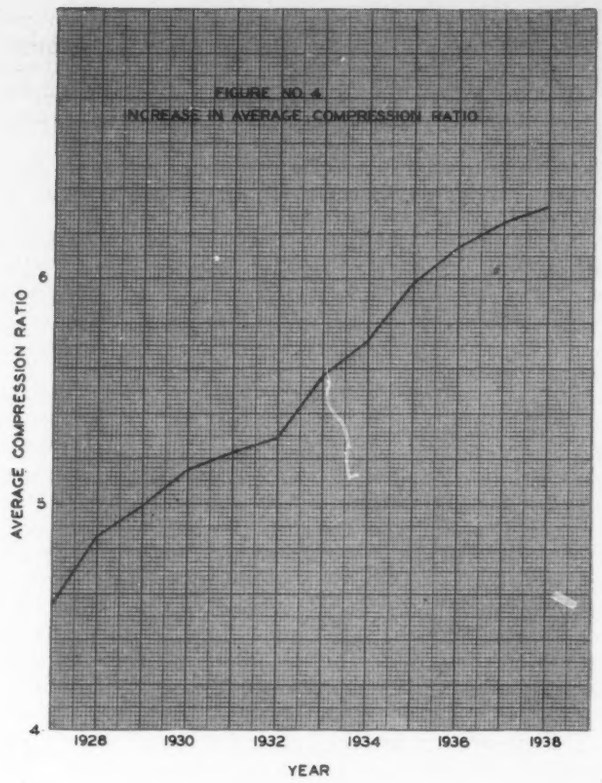
This increase in the number of cylinders in the modern engine has done much for smoother performance, but it is also not without significance to the refiner, due to the increased difficulty in securing a uniform fuel mixture to all cylinders, and the effect of this on fuel requirements.

CHANGES IN MOTOR FUELS

The previously discussed improvements in automobile engine performance could not have been consummated without the cooperation of the refiner. Far reaching changes were necessary in the characteristics of motor fuels in order that the increased performance resulting from higher compression ratios, higher speeds, and increased number of cylinders could be realized. As the compression ratio and power output of the automobile engine has been increased, it has become more and more apparent that the modern engine was very quick in differentiating between fuels suitable and unsuitable for its operation. Moreover, this selection is based largely on two factors, namely: the structure of the hydrocarbon molecules in the fuel, and the volatility of the fuel. If the engine and fuel system are both considered, this latter factor increases in importance.

If a given gasoline were burned in a series of engines of increasing compression ratio or increasing compression pressure, it would be noticed that, in general, the amount of detonation or knocking increases with the higher compression pressures. Therefore, the steady increase of compression pressures in the automobile engine has demanded a corresponding increase in the ability of the fuel to resist detonation. This property of motor fuels is expressed in terms of octane numbers. The octane number being the percent of iso-octane (2,2,4 trimethyl pentane) in a blend with normal heptane, which has the same knocking characteristics as the fuel in question, when tested in accordance with a specified procedure on a specified test engine. This test has been in general use only since about 1931 and had undergone several modifications since that time. Actual





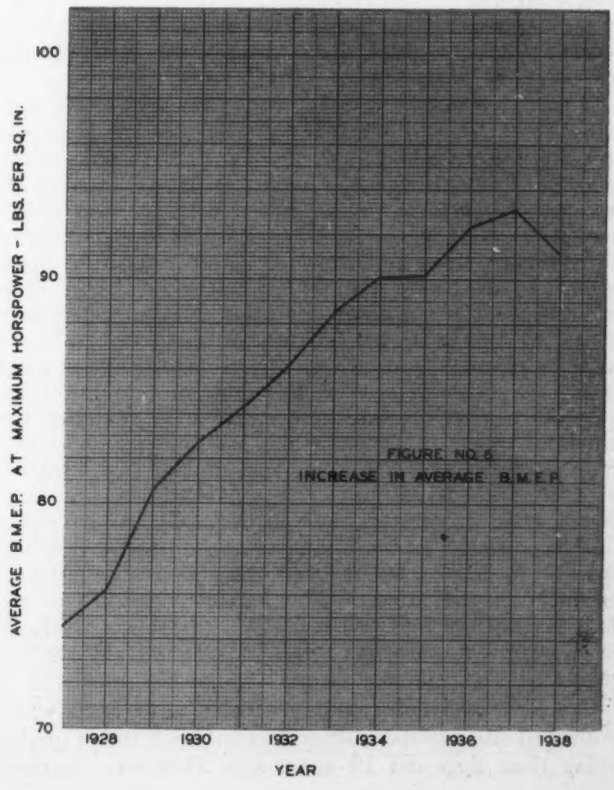
averages are, therefore, not available; however, Brown[3] has estimated the average values from 1927 to 1935, and additional values have been secured from surveys of motor fuels marketed. Figure 6 is therefore an estimated curve, showing the increase in the average octane number of regular or house brand fuels over a 10-year period. In 1928 it is estimated the average octane number of house brand gasoline was 51, while today it is approximately 71 (ASTM). This represents a tremendous change in the character of such gasolines and, judging from curves 4 and 5, the trend of engine compression pressures is still upward, which means a corresponding continuation of the octane number increase.

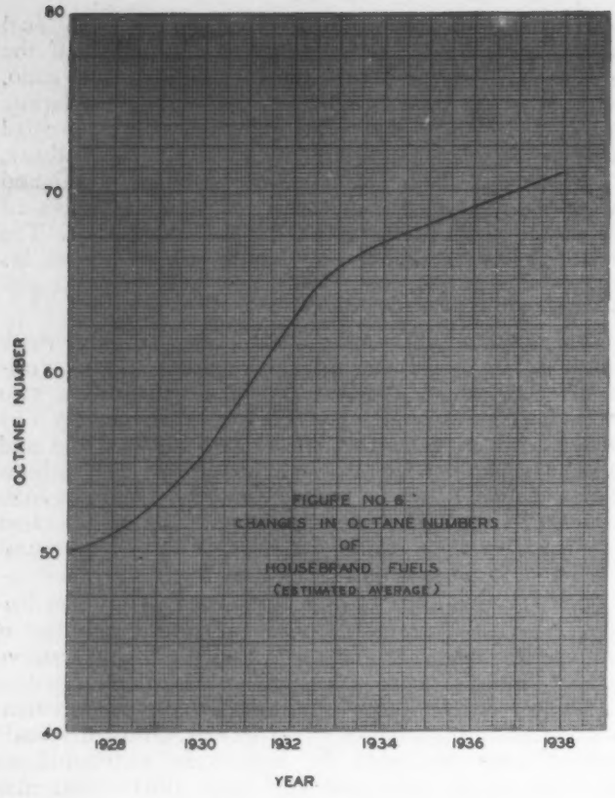
However, the refiners' problem is vastly more complicated than appears on the surface. Simply increasing the octane number is only a partial solution of the problem of supplying satisfactory fuels for modern engines. In any line of endeavor a constant standard of comparison capable of satisfactory gradation is necessary if the progress made is to be quantitatively determined. The octane number scale has been the refiners' standard for measuring the improvement in, and establishing the anti-knock characteristics of his fuels. Paradoxically, however, the octane number lacks considerable of being a true standard for such use. The ultimate value of motor fuel is determined by its behavior in actual service. This criterion is, however, so very complex that it can only be considered in terms of generalities, and can be used by the refiner only to a very limited extent. Under the guidance of the Cooperative Fuel Research Committee, five extensive test programs have been carried out for the purpose of correlating laboratory octane numbers with road performance. These have all shown that in many cases, wide divergence may be expected not only between cars of different makes and models, but between different cars of the same make and model. When we consider that the severity of detonation of fuels in an automobile in the hands of an average driver is judged (1) by his objection to the sound produced (and this may vary greatly with the individual) and that it also depends upon (2) fuel factors such as the inherent anti-knock quality of the gasoline, (3) engine factors, such as compression ratio, spark advance, manifold design, carbon accumulation, etc., and (4) operating factors such as speed, road grade, atmospheric temperature, humidity, and others, it seems very problematical if any laboratory method can ever be devised which will be a precise index of fuel anti-knock performance in the automobile. The refiner is therefore handicapped by the fact that his guide and accepted quality standard lacks accurate significance.

Vast amounts of research and development work have been directed toward the solution of the anti-knock problem. In general, the refiner is using two methods for the production of such fuels, namely (1) the addition of tetraethyl of lead to his gasoline and (2) the production of gasolines containing hydrocarbons whose chemical structure is such that they possess high auto-ignition temperatures, and low rates of reaction increase with temperature, the requisites of high natural resistance to detonation.

The use of tetraethyl of lead for octane number improvement of gasoline is now so widespread that it practically constitutes standard practice. A conservative estimate indicates that at least 75 percent of the gasoline sold today contains this anti-knock agent in concentrations of from 0.1 to 3.0 c.c. per gallon. Originally fuels treated with tetraethyl of lead were only sold as premium grade fuel; however, since 1933 it has also been a constituent of house brand or regular brand gasolines.

In spite of the fact that, as the use of tetraethyl lead increased, it has been manufactured at lowered costs and that such savings have in large measure been passed on to the refiner, the addition of this agent to motor fuel represents a very large expense item. The refiner, therefore, has had to study the factors involved in the use of lead tetraethyl, and has recognized the importance of





lead susceptibility and lead response in his fuels, and has had to control refining operations with these factors in mind. A recent development along this line is the recognition that sulfur and sulfur compounds such as di-sulfides in gasoline, lower the lead response and established treating methods have undergone many revisions in order to eliminate undesirable sulfur or sulfur compounds.

The successful use of lead tetraethyl has therefore demanded more from the refiner than the simple addition of this compound to his product, as it has been necessary that he prepare his base fuel so as to use this reagent most effectively.

In addition to the use of lead, the refiner has also found that the anti-knock characteristics of the base fuel previous to lead addition plays an important part in the road performance of his product. While road tests have not developed a precise relationship in this connection, there does appear to be a definite trend indicative of better performance from fuels of a given octane number made by adding a small amount of lead to a relatively high-octane-number base fuel, as contrasted with a fuel of the same octane number made by adding a large amount of lead to a relatively low-octane-number base fuel. Recognition of this has in part been responsible for the tremendous increase in cracking and reforming operations, since the gasoline made by this method has a natural high-octane number as contrasted with the low-octane number of most straight-run gasoline. Figure 7 indicates the yearly production of motor fuel constituents in the United States and it is very significant to note that in 1927 these constituents were produced in the ratio of 57.6 percent straight-run and 33.3 percent cracked, while in 1937 there was produced 45.0 percent straight-run and 47.9 percent of cracked gasoline.[4]

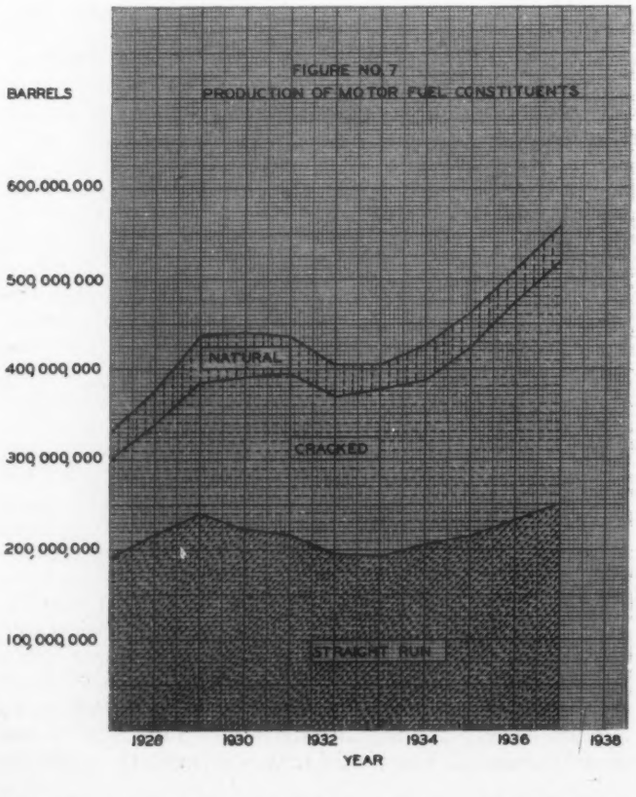
Cracking and reforming processes have been vastly improved and produce motor fuel of much better quality today than they did 10 years ago. However, research on these processes must continue as they are by far the major factors for consideration in future motor-fuel development. Other processes, however, are also being developed which will assist in raising the octane number of base fuels. Most noteworthy of these at the present time is polymerization.

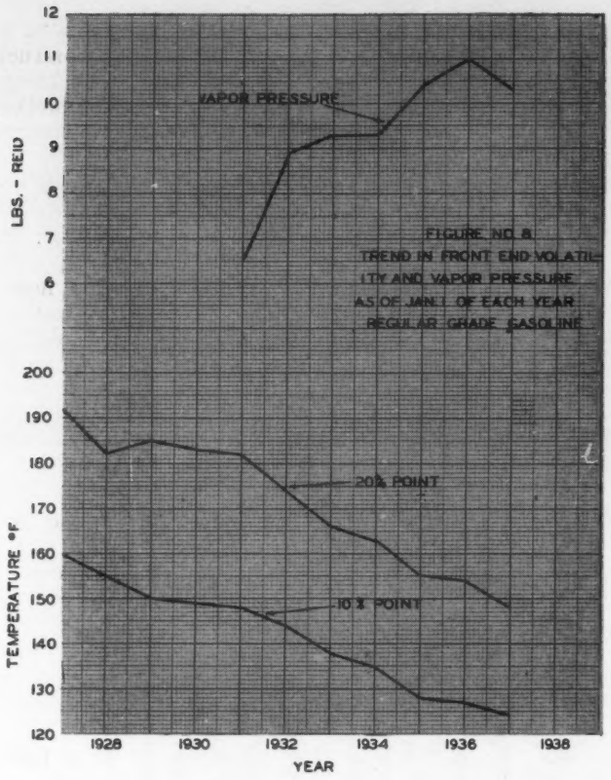
This produces a high-octane-number gasoline from cracking still gases, or when combined with cracking or dehydrogenation of natural gas, will convert a portion of the latter to high-octane motor fuel. Commercial utilization of this process is only several years old; however, it was recently estimated,[5] that polymerization plants now operating or under construction have an annual capacity of 10,500,000 barrels of 76-100-octane-number gasoline.

Other processes such as alkylation of low-boiling iso-paraffins and olefins, isomerization of straight-chain paraffins to either iso-paraffins or cyclic hydrocarbons, combinations of hydrogenation or dehydrogenation with alkylation or polymerization are being studied and developed. Undoubtedly the near future will see commercial installations for the production of high-octane-number gasolines by such methods. The importance of higher-octane-number base fuels has given great incentive to research and development work for the economic production of synthetic hydrocarbons which will impart this property, and which is becoming increasingly necessary with the continuation of present trends.

The importance of adequate volatility of motor fuels is well established. This property not only controls starting ability and operation during the warming up period, but is also related to fuel distribution to the cylinders, and therefore effects economy, acceleration, knocking and other features after the engine has reached operating temperatures. The importance of this has been demonstrated by numerous investigators and partially as a result, the volatility of motor fuels has shown a progressive increase,[4] as is shown in Figure 8.

This increase in volatility has not been demanded entirely by automotive design. Instead, it has more or





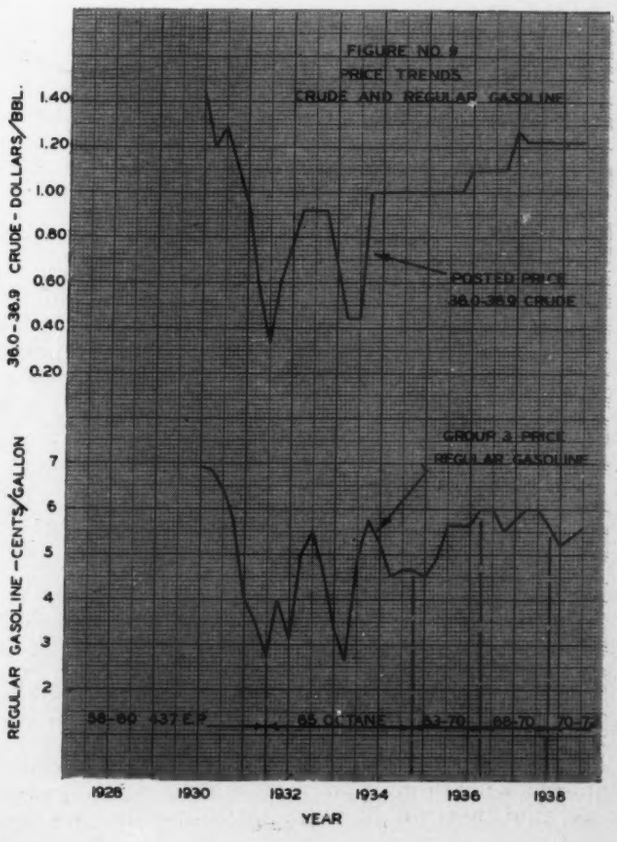
less been fostered by the petroleum industry. Several fundamental reasons have been responsible for this. Increased cracking and reforming, more efficient rectification and butane recovery have made increased volatility from the utilization of light hydrocarbons an economic necessity. High-octane-number requirements have been a further reason, since the high octane number of the butanes makes their inclusion desirable. Notable research has been carried out by Brown, Eisinger and Barnard, and others showing that increased volatility, if properly utilized, is a desirable feature. Increased volatility permits a more uniform mixture to reach all cylinders of the engine, resulting in better anti-knock performance and better economy. The increase in the average number of cylinders in the engine demands, therefore, a more volatile gasoline. Lower manifold temperatures can be used with more volatile fuels, and it has been shown[6] that a decrease of 15 to 20° in the intake manifold temperature is equivalent to an increase of one octane number in the fuel. Automotive engineers have taken advantage of this and manifold temperatures have been reduced. Late data on this are not available; however, Campbell, Lovell, and Boyce,[7] have shown that from 1931 to 1934, average intake manifold temperatures were reduced 30°, and that the tendency was toward further reduction. Satisfactory performance from automatic chokes, heating devices, etc., makes it necessary that they be adjusted for a certain expected volatility. The volatility trend has been recognized by the automotive industry and the modern car is therefore adjusted for best operation on volatile fuel.

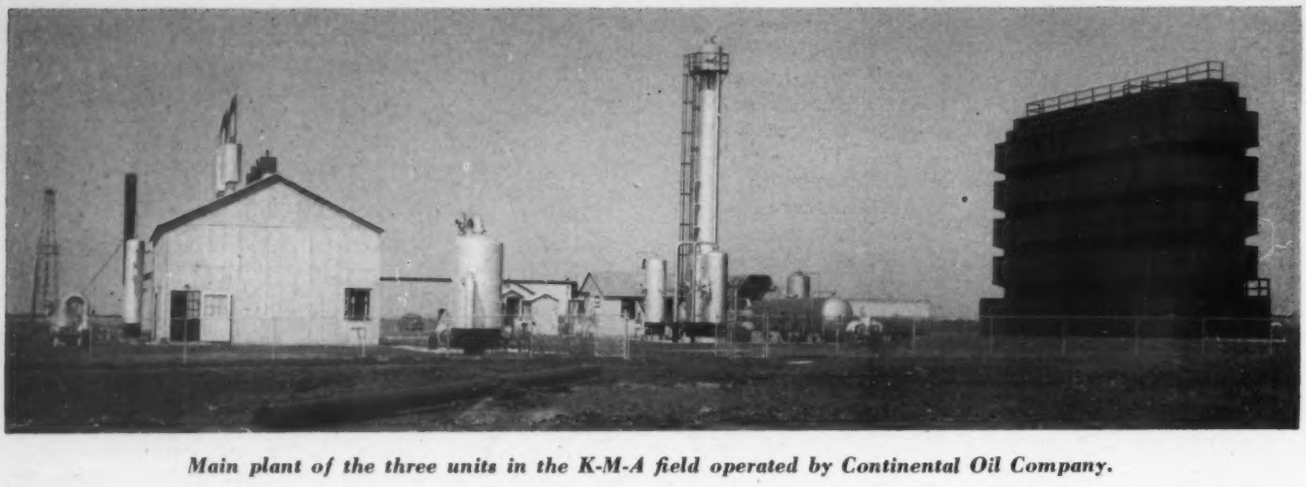
The chief factor limiting fuel volatility has been the tendency of cars toward vapor lock. Early work on this problem indicated that vapor lock was related to both fuel and automobile factors. Vapor pressure is apparently the chief fuel factor, and the amount of heat radiated to the gasoline-feed lines, and their vapor handling capacity the principal automobile factors. Progress has been made in automotive design toward the improvement of these latter two factors, in order to permit the use of higher-vapor-pressure fuels. However, many individuals have been of the opinion that this progress has been very slow. As a result, there was conducted last year, under the joint auspices of the Natural Gasoline Association of America and the Western Petroleum Refiners Association, a road-test program, known as the Pawhuska Road Tests, for purposes of studying the fuel systems of representative 1937 cars. It was found that wide differences exist in this respect. In order to produce cars which could utilize more volatile fuel, some manufacturers have built fuel systems so arranged that a minimum amount of heat is radiated to them. Others, however, have depended largely on the vapor handling capacity of the fuel system, and the vented carburetor, which vents any fuel vaporized in the feed lines to the atmosphere. It was found that, while this latter system assists in eliminating vapor lock, it wastes considerable amounts of fuel. Moreover, the fuel vented is made up of the most volatile constituents, having a high octane number, and therefore the engine is actually operated on a lower-octane-number, poorer volatility fuel. Over-all fuel losses, including the loss from the rear tank, were found to be, on some cars, as high as 4 percent and over, depending upon the type of driving.

Just how much of this fuel and octane number loss has been eliminated in later models, is not known. However, the carburetor design of one 1939 model has been called to the writer's attention. In it the carburetor vents into the air filter, so that any fuel vented from the carburetor is recycled with the incoming air and loss prevented thereby.

From an over-all viewpoint, it is therefore necessary that, in order to make satisfactory motor fuel, the refiner of today must produce a base gasoline not only by the skimming of crude, but also by extensive crack-

(*Continued on page 651*)





Main plant of the three units in the K-M-A field operated by Continental Oil Company.

K-M-A Combines
Gasoline Extraction
With Repressuring

J. C. ALBRIGHT

AS the new K-M-A oil field in North Texas has been extended by deep drilling to include more territory, producing from sands and limestone formations beneath the area which saw a wild scramble for acreage almost 20 years ago, the present operators are becoming interested in pressure maintenance to the end that three companies have secured large blocks of casinghead gas contracts so that gasoline manufacture can be tied in with pumping dry gas back into the producing reservoir. The first company to install equipment for natural gasoline extraction in this area is Deep Oil Development Company, an organization local to Wichita Falls, with Phillips Petroleum Company-Sunray Oil Company as second in the picture. Following closely upon the erection of Phillips-Sunray plant, came the unit construction of Continental Oil Company's extraction plants. These are equipped to compress gas to 2000 pounds for injection.

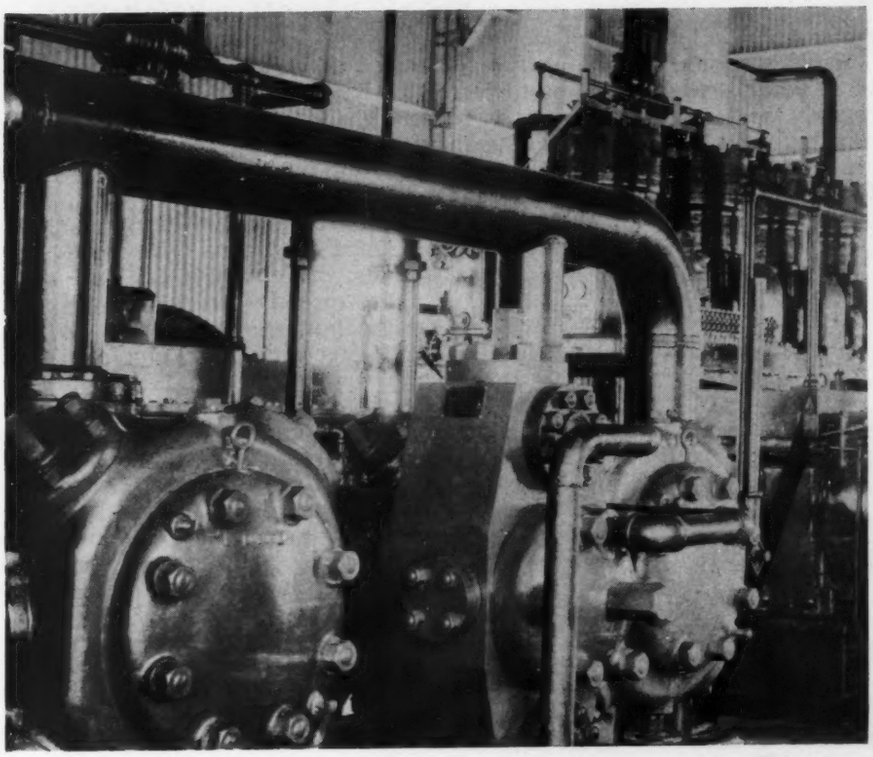
With Continental Oil Company's plants, a different scheme is used in gasoline plant construction, differing from the usual booster plants surrounding a central extraction plant by making each of the units in the system complete plants, with the exception of stabilization, which is conducted at one plant as gasoline, raw and carrying all fractions condensed at 300 pounds, flows continuously from the auxiliary plants to the fractionator supply storage tanks. This company decided upon auxiliary plant construction because, as with boosters, approximately the same amount of labor is required for either, but considerably less of field lines are required for the unit plant construction. With each plant functioning as a separate unit, it may operate without interruption, even if the main unit is shut down.

Building of all three units began simultaneously. The first unit, or the main plant, which is a complete plant in itself, called Plant No. 33, is located beside the road from Kadane Corner to Iowa Park. Auxiliary Plant No. 1 is a mile southwest of Kadane Corner, and was designed to use a single 400-horsepower gas engine. Auxiliary Plant No. 2 is a mile northwest of Valley View school house. Each of the three units is connected to the main plant with only a raw gasoline transfer line, and the inter-plant telephone communication system, and each plant has its individual operating personnel, directed by a central office. They are maintained by a single repair crew that goes from one to the other as occasion demands.

The main plant is equipped with two 400-horsepower angle-type gas engine driven compressors, rated at that horsepower when running at 300 revolutions per minute, and these engines have 14 x 14-inch power cylinders. The compressor cylinders are four in number, with the first cylinder 29 inches in diameter with a 14-inch stroke, and two 10½ x 14-inch intermediate cylinders that have a pressure capacity of 300 pounds per square inch. To complete the compression cycle, the fourth cylinder is a single-action unit, with a bore of 2¾ inches and a stroke of 14 inches, capable of boosting residue gas to a pressure of 2000 pounds per square inch and with a

volume of 250,000 cubic feet. Each of these units may draw from the field separators through the main gathering system and intake headers, gas at 10 inches Hg. vacuum and an amount of about 2,000,000 cubic feet per day, compress through three stages —30 pounds low; 300 pounds intermediate, and 2000 pounds high—make gasoline and repressure deep producing formations in a continuous operation.

No. 2 plant has identical engine equipment, and No. 1 auxiliary has only one of the same type engines. All engines are cooled with jacket water circulated in a closed system with centrifugal pumps. The water flows to the cooling tower basin to exchange heat with cold water through atmospheric type sections with bronze tubes. Each section of these atmospheric coolers has 614 square feet of surface, which reduces the water to required operating temperature. The engines are compact units, 10½ feet from compressor cylinder head to back of crankcase, and 12 feet 6½ inches from flywheel to opposite end of crankshaft. A new feature in these engines is the lubrication system employed, which includes oil cooling in outside water-cooled tubular units. The oil is pumped through a continuous filter, cooled, and flows through drilled conduits, or passageways in the crankshaft to rifle drilled connecting rods. Connections and drilled passageways carry this oil at high velocity and with large volume to a hollow space cast into the piston head above the piston pin to lower piston temperatures for increased performance, and lowered cost because of lessened cylinder, piston and piston ring wear. Coking of oil in this chamber is prevented by the high velocity which is said to keep the skin temperature of the lubricating oil below the temperature where coking occurs.

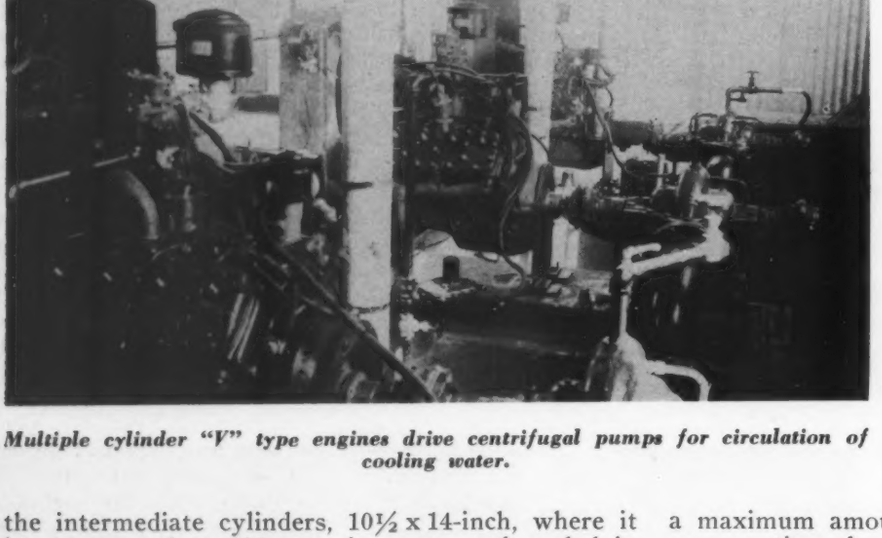


At the main plant are the various units required for stabilizing the raw compression gasoline after it is manufactured at the main plant and received from the two auxiliary plants. Sufficient pressure is maintained on the high pressure accumulators, working at a minimum of 300 pounds, gauge, to pass the raw material to the fractionating column work tank for that unit's working pressure of 175 pounds, and pumped to the stabilizer, where the method followed is more or less conventional, using atmospheric sections for condensing reflux and exchangers and coolers for handling finished production. The functioning of each plant is similar to

Angle type gas engine driven compressors handle gas through three stages.

the other in the manner in which gas is received from the wells, and the intake manifold is under approximately 10 inches Hg. vacuum at all times. This does not mean that a vacuum of this amount is maintained on the traps and separators, but is used so that all gas may be brought in without distant separators popping through their vent lines when flowing allowables. Each plant is equipped with an intake scrubber to prevent intake of liquids. Each scrubber is equipped with safety devices in the form of float-controlled electric switches that are connected to the magnetos and short out these units if and when fluid enters the plant in volumes too large to be handled successfully. The scrubbers are 6 feet diameter and 10 feet high, set on concrete pads near the intake manifold.

The gas is handled first by the 29 x 14-inch low pressure cylinder on each engine, which compress the gas from 10 inches Hg. intake to 30 pounds, with gas and condensate flowing through two single-pass atmospheric cooling sections and back to the low pressure accumulator, or scrubber. Condensate is retained in this vessel, which is 4 feet by 10 feet, installed vertically, with the gas passing directly to the intermediate cylinders, 10½ x 14-inch, where it is compressed to 300 pounds gauge and cooled in two single-pass atmospheric units for condensing the bulk of the available gasoline. Until repressuring is begun, the stripped gas enters field fuel lines, plant fuel systems for gas engine and boiler fuel—in the case of the main plant—and as fuel for residences of the employes.



Multiple cylinder "V" type engines drive centrifugal pumps for circulation of cooling water.

The low pressure, or first stage accumulator tank in each of the three plants is equipped with two float controllers, one of which operates the pump that removes condensate from the vessel into the high-pressure accumulator, and the other is attached to a mercury switch connected with the magneto on the engine as a safety measure. Gas handled by the intermediate cylinders is processed by compression and cooling, with condensate flowing from the receiver to the pipe line connecting the auxiliary plant with the main plant for stabilizing. With the main plant, the combination of low and high pressure production is transferred through a short pipe line to the 6 x 30-foot work tank where it is available for stabilizer feed.

Steam required for reboiler and processing heating is obtained with two "oil field" type boilers fired with gas, and supplied with steaming water from a surface reservoir filled with run-off water from rains. Steam is also used for several pumps operating in the main plant using mainly reciprocating units for stabilizer feed, reflux control, water circulating and for pumping finished gasoline to the loading rack near Iowa Park.

Water for plant use is obtained from shallow wells, produced by controlled gas lift, with the surface level of the cooling tower basin as a guide to the volume a well must produce. Cooling towers at the three plants vary in size, due to the amount of work required of them. The main plant has a 10-bay structure 66 feet long, 23 feet wide and 46 feet high, with atmospheric sections installed to handle gas, gasoline, engine-cooling water and other necessary cooling for a plant of this nature. No. 2 unit has a cooling tower with 6 bays, and is 42 feet long, 24 feet wide and 46 feet high, and contains gas cooling coils as well as main gas engine jacket coolers. No. 1 unit, being the smallest of the three, has a 4-bay tower 30 feet long, 23 feet wide and 46 feet high.

Water circulation is obtained at No. 2 auxiliary plant with three V type 8-cylinder gas/gasoline engines which are directly attached to centrifugal pumps, housed in a building 16 feet wide, 24 feet long and with 8-foot eaves, all steel, with concrete floors. All engine rooms, as well as boiler room, are floored with terrazzo flooring, which adds much to the appearance of the equipment and surroundings.

All plants and dwellings are lighted by current generated within the plants, produced in the main plant with a 20 kva., 110 volt, a.c. generator, which, like the water pumps, is driven by a V type 8-cylinder gas/gasoline engine. Other units have smaller generators, depending upon the amount of lighting required. Lighting is handled in the yards with tower-supported floodlights, which are located so as to afford a maximum amount of illumination with the least consumption of current.

From an analysis of the gas produced in this field, it is evident that the finished gasoline must be treated to remove sulphur compounds, and a dry copper sweetener is furnished at the main plant where shipments are made to loading rack. Analysis of gas is as follows:

Fraction	Mol Percent
Methane	41.18
Ethane	13.82
Propane	22.10
Butanes	14.33
Pentanes Plus	7.51
Air	.96
Acid gases	.10
Total	100.00

The gas varies in available natural gasoline fractions, depending upon whether it is produced from sand or lime, and as to the area from which it is recovered. In some instances, a test car will uncover a lease which has a high content, running over 6

The Number 2 auxiliary plant operated by Continental Oil Company in the K-M-A system.

gallons per thousand in some instances, and again a lease may be found which will show as low as 2½ gallons. Very little, if any, gas is produced with the oil in the old wells, but occasionally a well is producing sufficient gas to justify connection.

Gasoline plants are becoming more involved as each is built, with oil production problems, repressuring in particular, and these plants were constructed with a dual purpose, one to extract the reuired fractions available for commercial natural gasoline, and the other to return surplus gas to the formation. As each new field is discovered, and if gas is produced in quantities, plants are designed for the dual purpose, and operators more and more are being required to add to their knowledge of operation to include certain phases of producing practices that make them an ally with men in the field, rather than the traditional enemy as things have gone in the past.

The cycle of gasoline plant operation is repeating itself. In the early stages of the industry, compression was the rule, running into two stages with expander units sometimes attached to the plant. Then came absorption, at comparatively low pressures, but with the advent of repressuring and extraction of gasoline from some types of gas, high pressures with compression extraction makes itself felt again.

Undoubtedly, when K-M-A is defined, and production of oil will permit an increased drilling campaign, other plants will be built in that territory, and from a conservation angle, most of them will concern themselves with high pressures, sufficiently high that gas may be returned. Eventually this gas will be handled many times, becoming of a different composition with each period of circulation, and from an operator's standpoint, he must familiarize himself with more phases of gasoline plant operation than he has in the past.

Motor Fuel Demands

(*Continued from page 647*)

ing, polymerization, and other methods in order to produce a base gasoline of high natural octane number. To this, sufficient tetraethyl lead must be added to meet accepted sales quality standards. In addition, the fuel must also meet accepted volatility requirements. The trend in these demands shows little let-up of increasing severity and the successful accomplishment of these objectives demands that the refiner carry out continuous research work of a very wide scope and continuously modernize his equipment and manufacturing methods in accordance, in order to maintain his position.

All of these operations involve added expenses, which normally should be reflected in gasoline prices. This has not been the case, however, and, while the modern engine can hardly be blamed for the refiner's failure to secure an adequate return for the improvements he has made in motor fuels, nevertheless this unsatisfactory economic condition greatly adds to the refiner's burden.

Figure 9 shows the price history of Mid-Continent crude and regular-grade gasoline. It shows that the price trend of gasoline has not kept pace with the price trend of crude oil. The refiner is, therefore, faced with a condition whereby the cost of his raw material has increased faster than the selling price of his product. In addition, manufacturing expenses have increased, due to increased cracking and reforming, the use of lead, higher labor rates, and similar items. To carry out these operations, tremendous capital investments have been made in equipment with resulting high depreciation and interest charges. All of these items, therefore, mean a higher manufacturing cost. As offsetting features, this newer equipment is much more efficient and has thereby effected some reductions in cost due to better fuel economy and higher recovery. The refiner who has not been able to install new equipment and modernize his old, finds himself in a difficult position and can only hope to subsidize his manufacture of motor fuel from revenues derived from other products or operations.

Ultimately adjustments of this situation must take place; however, today the refiner is giving more than the value received for his gasoline.

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Cracking Fuel Oil to Coke

K. M. WATSON
Universal Oil Products Company

Delivered before Regional Technical meeting of the Western Petroleum Refiners Association, Wichita, Kansas

FOR several years, it has been unusually difficult to balance refinery operations for optimum profitability at all times due to fluctuating market requirements resulting from alternate periods of industrial activity and depression. At present we are confronted with a surplus of heavy fuel oil that extends to practically all parts of the country. In some districts, requirements for furnace distillates and Diesel oils have increased out of proportion to the increase in gasoline demands, and difficulty is encountered in maintaining suitable balances among these products.

In order to meet conditions such as these, it is necessary that refiners be provided with cracking equipment of utmost flexibility, adaptable to today's fuel oil surplus and low prices, but at the same time capable of most effectively meeting increased markets for heavy cracked fuel oil which may result from renewed industrial or military activity.

The solution to the present fuel oil problem is the conversion of fuel oil to gasoline or furnace distillates and coke. With recent improvements, the cost of continuous coking has been greatly reduced and this operation offers an admirable means of balancing refinery operations through wide ranges of market fluctuations. Coke is a valuable fuel, possessing many superior properties for which it is possible to develop markets in almost all localities. Furthermore, it is a product which, if necessary, can be stored at low cost substantially without deterioration and disposed of when marketing conditions are most favorable.

THE CRACKING UNIT

The ideal equipment for cracking topped or reduced crudes to coke is centered about the modern two-coil cracking unit designed for optimum results when producing high-grade cracked fuel-oil residuum. Addition of properly balanced coking equipment to such a unit results in a combination which assures optimum results in either of the extreme cases of total residuum or total non-residuum operation and all intermediate combinations with or without the production of furnace distillates.

A simplified flow diagram of the basic cracking units is shown in Figure 1. In the majority of modern installations, this cracking plant is designed as a part of a combination crude-fractionating and cracking unit utilizing waste heat from the cracking section for topping. However, for simplification, only the cracking plant proper will be considered.

The topped or reduced crude charge is introduced to the side of the fractionating column where it is contacted with the recycle vapors from the flash chamber. The overhead product from the fractionating column is end-point gasoline. Furnace or tractor

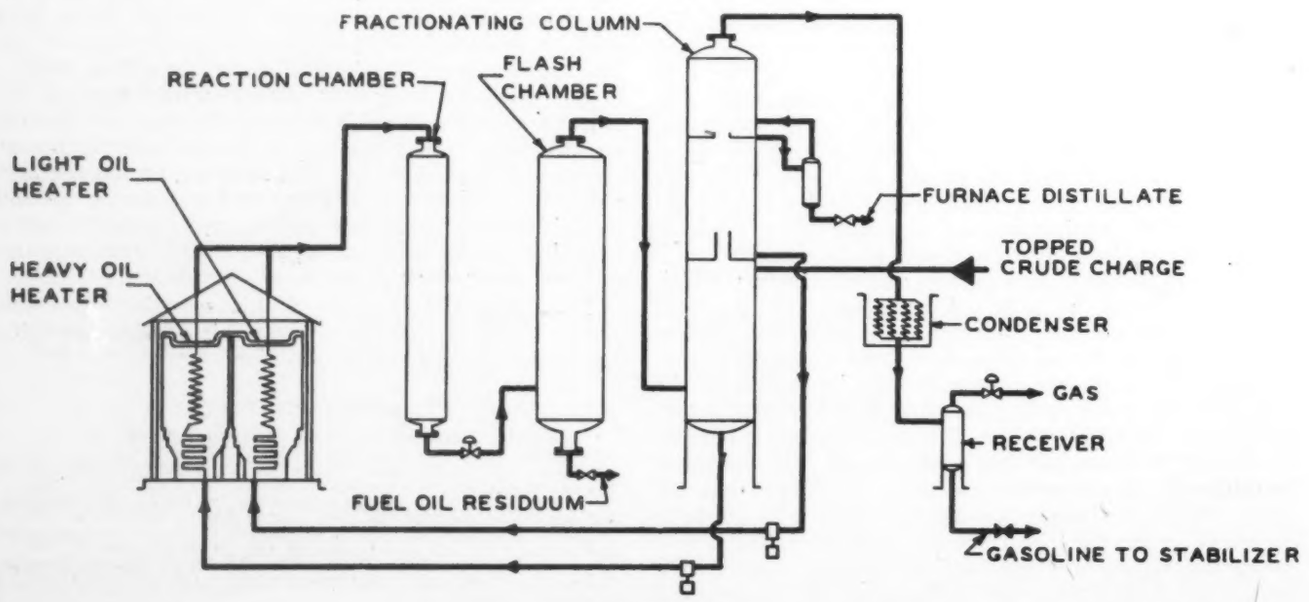


FIGURE 1
Flow Diagram of Two-Coil Selective Dubbs Crackin Unit.

distillates are withdrawn as a sidecut and stripped to specifications. From a lower sidecut tray a higher-boiling distillate comprising the lower-boiling fractions of both the recycle and charging stocks is withdrawn as charge to the light-oil heater. The charge to the heavy-oil heater is withdrawn from the bottom of the fractionating column, and consists of the highest-boiling fractions of both the recycle and charging stocks.

The transfer lines from the two heaters enter the top of a downflow reaction chamber. This chamber is operated without a liquid level, all products being withdrawn from the bottom through a pressure-control valve.

The mixture leaving the reaction chamber after suitable quenching enters the flash chamber in which a fuel-oil residuum of the desired properties is separated. The properties of the fuel oil are regulated at this point by suitable control of the inlet temperature and refluxing of the flash chamber. The vapors from the flash chamber pass to the lower section of the fractionating column to complete the cycle.

This type of two-coil selective cracking unit has

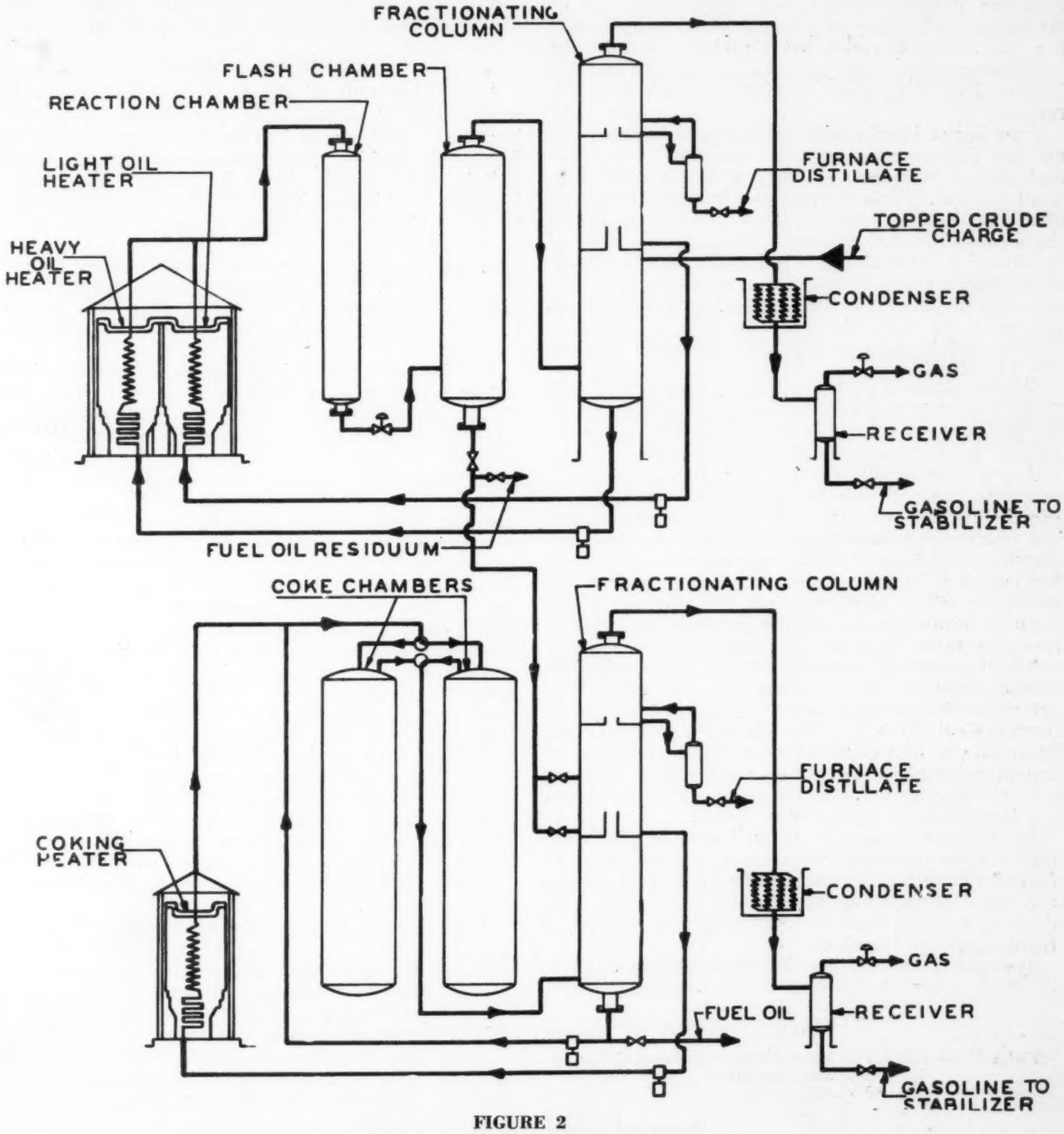


FIGURE 2
Flow Diagram of Extended-Type Coking Unit.

produced optimum results when processing a wide variety of residual stocks. With the development of the Equiflux heater and its incorporation into the two-coil selective plant described above, it is possible to obtain temperatures as high as 920° F. in the middle of the reaction chamber. With a reaction chamber operation at this temperature level the heavy charge is subjected to a far greater time-temperature action than can possibly be achieved without the use of the reaction chamber as a means of viscosity breaking. As a result, yields are improved, and at the same time plant costs reduced due to the greatly increased cracking rates obtained at high temperatures.

Cracking residual stocks at high temperature levels has further advantage in resulting in cracked fuel oils of maximum stability and minimum sediment content. These properties are direct functions of the average temperature level of cracking, and in the modern two-coil unit the average temperature of the entire reaction chamber is greater than the maximum temperature ordinarily attained in coil-only viscosity breaking. For this reason, superior fuel oils are produced even though they are more highly cracked and have yielded greater quantities of gasoline and distillate.

Similar results to a lesser degree may be obtained in a single-coil and reaction-chamber unit in which the charge passes through the heater with all of the recycle stock. However, the two-coil unit by separating a considerable portion of the combined feed in a stream which can be heated to very high temperatures is able to operate with higher average furnace and reaction-chamber temperatures and more fully employ the advantages of high-temperature reaction-chamber cracking. In very large units it is sometimes desirable to employ more than two coils, but the advantages of such multiple coil arrangements are slight as compared to the basic two-coil plant.

To illustrate the comparative results obtained in various methods of processing, the following yields are presented as representative results when charging a typical 25° A.P.I. Mid-Continent reduced crude having a viscosity of 20 S.F.S. at 122° F. In considering these results, it must be remembered that not only the gravity but also the viscosity of the charge are important in determining yields.

In the first column of Table 1 are the yields obtained when operating to produce only gasoline and fuel oil of 200 S.F.S. viscosity. In the second column are the corresponding results obtained when withdrawing a large fraction of distillate meeting No. 2 furnace oil specifications.

It should be noted that the cracked gasoline yields of Table 1 are all reported on the basis of 400 end-point and 10-pound Reid vapor pressure. On the basis of total butane-butylene retention in the gasoline the yields would be increased approximately 4 percent and 3 percent respectively. The yields of catalytic polymer gasoline shown in the tables are on the basis of polymerizing 80 percent of the propylene and butylenes formed in the cracking operation. The most profitable degree of polymerization recovery will vary above and below this figure depending on size of installation and other local conditions.

TABLE 1

Yields From 25° A.P.I. Mid-Continent Reduced Crude In Residuum Operation

	Maximum Gasoline	Maximum Furnace Oil
Percent by Volume of Charge:		
Gasoline, 400 E.P., 10 RVP	53.5	38
Furnace Distillate	...	23
Fuel Oil	37.5	34
Liquid Volume Loss	9	5
Gas, cu. ft./bbl	500	290
Octane Number (A.S.T.M.)	69–70	68–69
Fuel Oil, Vis. S.F.S. at 122° F	200	200
Fuel Oil, Gravity, °A.P.I.	7	8
Percent Catalytic Polymer Gasoline, 10 RVP	5	3.5
Percent Total Gasoline, including Polymer	58.5	41.5
Octane Number of Total Gasoline	71–72	70–71

EXTERNAL COKING

A cracking unit of the type described above is readily adapted to coking by the addition of a coking section which may be operated entirely separate from the cracking plant. The resulting combined unit is shown schematically in Figure 2. Residuum from the cracking section is discharged to the column of the coking section where it may be mixed with recycle stock from the coke chambers or may be charged directly to the coke plant heater. In the coking heater, the temperature of the residuum is raised to the range of 900-950° F. dependent on the type of operation employed and the quality of coke desired.

The furnace transfer is manifolded through switch valves to the tops of the coke chambers which are alternately filled and cleaned. Vapor outlet lines from the tops of the coke chambers are manifolded through similar switch valves to a vapor line leading to the coke plant column. The bottom section of this column serves as a flash chamber where any desired quantity of heavy coke chamber cycle stock may be condensed. This material is a highly cracked distillate which may be withdrawn from the system and marketed as a low cold test fuel oil of superior properties. If it is not desired to withdraw fuel oil at this point, only a minimum amount of condensation is produced as a means of removing the heaviest ends of the coke chamber vapors. In this case the bottom section acts primarily as a trap to guard against carry-over as a result of misoperation in filling the coke chambers. Any material collected in this way is pumped back to the coke chamber inlet.

The coke plant column is provided for the withdrawal of a furnace distillate sidecut and end-point gasoline as an overhead product. The furnace distillate produced in the coking section may be withdrawn for sale or may be returned as charge to the cracking section when it is desired to produce maximum gasoline.

A unit of this type possess extreme flexibility and can be operated in any desired combination of coke and fuel oil production ranging from complete coking to produce maximum ultimate gasoline yield down to the production of a minimum quantity of coke representing only a few percent of the charge. If no coking is desired the coking section of the unit may be operated as a single coil topped crude cracking unit with one coke chamber serving as the reaction chamber.

The control points in the operation of the unit for producing different balances of products are as follows:

(1) The amounts of furnace distillate withdrawn from both columns;

(2) The viscosity of the residuum produced in the cracking section;

(3) The amount of fuel oil withdrawn from the flash chamber of the cracking unit;

(4) The amount of fuel oil withdrawn from the coke plant column;
(5) The amount of furnace distillate returned from the coking to the cracking section;
(6) The pressure at which the coking section is operated.

If it is desired to produce only gasoline and coke the cracking unit is operated to produce a heavy residuum of high viscosity. No fuel oil is withdrawn from the coking column, and maximum recycling of coke chamber distillate is employed. The furnace distillate withdrawn from the coking column is returned to the cracking unit and no furnace distillate is withdrawn from the cracking plant column. In this operation the coke plant is operated at maximum pressure.

As an opposite extreme, is an operation in which only a minimum quantity of coke is produced together with some fuel oil and furnace distillates. In this case, the cracking unit is run to produce a lighter residuum which is charged to the coking heater in a substantially once-through operation. The coke chambers are operated at minimum pressure, and the desired fuel oil fraction withdrawn from the bottom of the coking column. The sidecut from the coking column may be withdrawn from the system or returned as charge to the cracking section, permitting control of the ratio of gasoline to furnace distillate. In this operation, all fuel oil withdrawn is composed of the high boiling fractions of the coke chamber distillate.

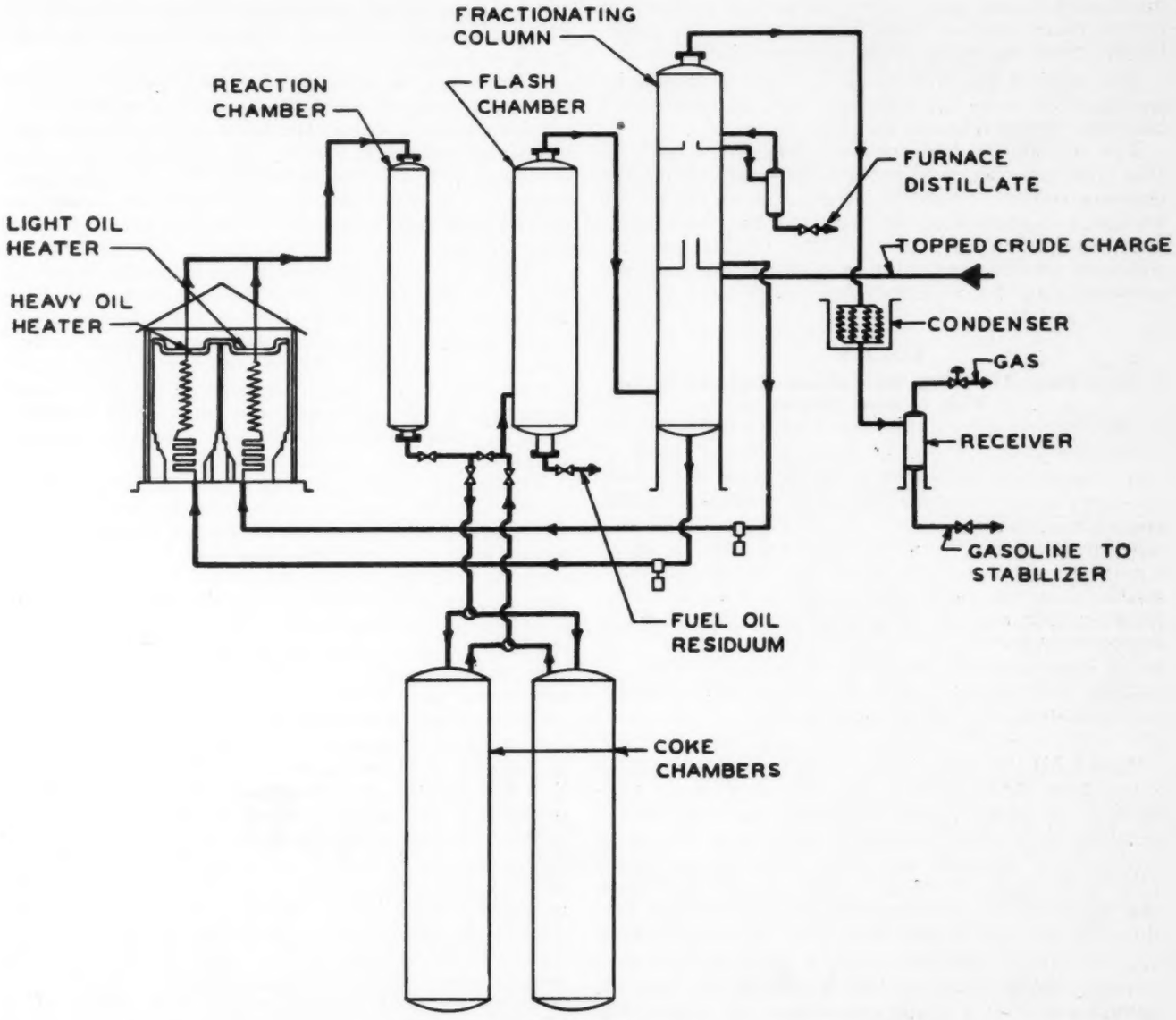


FIGURE 3
Flow Diagram of Integral-Type Coking Unit.

Consideration of the flow diagram will suggest many other possible operations intermediate between those described. For example, in some cases, it is desirable to withdraw a portion of the residuum produced on the cracking unit and charge only a part of it to the coking section. The residuum withdrawn may be flashed to a high viscosity and cut back with distillate withdrawn from the coke plant column. Coke plant distillates are materials of low hydrogen content and an aromatic nature which makes them excellent blending stocks for reducing the viscosities of fuel oils.

Table 2 summarizes the yields obtainable in four

of the operations described above when charging the same 25° A.P.I. Mid-Continent reduced crude previously considered. In the first column only coke and gasoline are produced. In the second column a maximum yield of furnace distillate and gasoline is produced. In the third column, the plant is operated to produce minimum coke, 200 S.F.S. fuel oil, and gasoline. The fourth column presents the results of an operation similar to that of the third column except that maximum furnace distillate is withdrawn. As mentioned above, many other balances of production intermediate between these four extremes are possible by varied operating cycles and conditions.

The cracked gasoline yields in Table 2 would be increased by from 4 to 6 percent were all butane and butylene included in the gasoline.

The operability and time efficiency of a unit of this type is a matter of prime importance. Since the cracking section is entirely independent of the coking section, this portion of the plant will have the inherent operability of the two-coil unit of this type. As previously mentioned, runs of 60 days' duration are common-place for well operated plants.

TABLE 2

Yields From 25° A.P.I. Mid-Continent Reduced Crude With External Coking

	Max. Gasoline and Coke	Max. Furnace Oil and Coke	Coke, Fuel Oil and Gasoline	Coke, Fuel Oil, Furnace Dist. and Gasoline
Percent by Volume of Charge:				
Gasoline, 400 E.P., 10 RVP.	70	49	63	42
Furnace Distillate	..	29	..	30.5
Fuel Oil	..	..	18	14.5
Liquid Volume Loss	30	22	19	13
Coke, lbs., per bbl.	65	47	29	23
Gas, cu. ft., per bbl.	940	730	750	470
Octane Number (A.S.T.M.)	68–69	67–68	68–69	67–68
Percent Catalytic Polymer Gasoline, 10 RVP	7	5.5	5.5	4.5
Percent Total Gasoline including Polymer	77	54.5	68.5	46.5
Octane No. of Total Gasoline	70–71	69–70	70–71	69–70

Despite the fact that the coking heater is handling a cracked residuum, the operability of the coking section is approximately the same as that of the cracking unit. This results in part from the great advances in furnace and tube bank design which have been made in recent years, and in part from the high quality and stability of the residuum produced in the high temperature two-coil cracking unit.

In a recently completed run, a complete unit with external coking was operated primarily for gasoline production with a small withdrawal of furnace distillate. In this one run 68 coke chambers were filled during a period of 47 days without interrupting the operation. The unit was then run for fuel oil production, operating the coking section as a single-coil cracking unit. This operation was continued for an additional 18 days, making a total of 65 days during which the coking heater was continuously on stream. This unit in complete non-residuum operation has a charging capacity of 10,000 barrels per day of topped crude. With the coking section operated as a single-coil unit producing fuel oil, the capacity was increased by approximately 2500 barrels per day. The charging stock was a reduced crude of 20-22° A.P.I. gravity.

Another unit of similar design charging approximately 10,000 barrels per day of a 13° A.P.I. reduced crude recently filled 87 chambers with coke in one run over a period of 1001 hours. Each chamber contained 160 tons of coke.

INTEGRAL COKING

For large capacity installations in which a considerable degree of coking is required the external type coking unit described above is not only the most flexible but the lowest cost installation. For smaller capacities of the order of 2500 barrels per day of charge or less, an alternative scheme is available which although somewhat less flexible may be built at a lower cost.

A schematic flow diagram of this operation which is termed integral coking is shown in Figure 3. The cracking unit proper is the basic two-coil plant previously described. However, where integral coking is contemplated the design balance between the tube banks and reaction chambers is preferably somewhat altered to insure maximum reaction chamber outlet temperature.

When operating the unit to produce coke the mixture from the reaction chamber outlet is diverted by means of block valves directly to the coke chambers which are alternately filled and cleaned in a continuous operation. The vapors from the coke chamber are returned to the flash chamber of the cracking unit from which a heavy condensate may either be withdrawn as fuel oil or returned to the inlet of the coke chambers.

The integral type coking operation has proved very satisfactory for minimum cost installations of moderate capacity in which a substantial recycle ratio is maintained. Its flexibility is limited by this requirement of sufficient recycle stock to insure an adequate heat supply to the coking chambers. For this reason, it is not possible to operate such a unit to produce the wide range of products possible with the external type coking equipment. This limitation principally affects the proportions of furnace distillate and fuel oil which may be withdrawn from a particular charging stock. The heavier the charge the smaller the quantities of these materials which may be withdrawn from the operation without jeopardizing its operability due to insufficient recycle stock.

When the integral coking design is considered for large capacity installations, it develops that the advantage of lower equipment cost as compared to the external scheme is lost. In such cases the additional cost of the heater and extra fractionating equipment in the latter scheme is more than offset by the increased costs of the cracking plant vessels and particularly the coke chamber piping and switch valves of the integral scheme. It will be noted that in the integral scheme the coke chamber piping and switch valves must be of sufficient size to handle the entire combined feed of the cracking unit while in the external scheme only the relatively small coking plant feed stream passes through these valves and piping.

Where the integral scheme is operable, the results produced are substantially the same as those of the external scheme. There is perhaps a tendency toward the production of more gas in the integral scheme due to the fact that all gasoline produced in the unit is subjected to the time-temperature conditions of the coke chambers. However, any increase in gas production obtained in this manner is offset by corresponding improvement in octane number.

When charging the 25° A.P.I. Mid-Continent reduced crude previously discussed, the integral coking

unit can be operated to produce the results shown in columns 1 and 2 of the Table 2. By withdrawal of fuel oil from the flash chamber and by-passing a portion of the mixture leaving the reaction chamber directly to the flash chamber, operations approaching those indicated in columns 3 and 4 may be produced. Added flexibility may be obtained by providing by-pass lines through which all or a portion of the light oil heater stream may be by-passed around the reaction chamber directly to either the tops or bottoms of the coke chambers. This modification permits satisfactory coking with somewhat lower recycle ratios than are possible with the flow shown in Figure 3.

An integral type coking unit charging a 21° A.P.I. reduced crude recently completed a 70-day run during which 65 chambers were filled with coke. Substantial quantities of cracked fuel oil were withdrawn as required.

PRE-COKING

A third method of approaching the coking problem has proved desirable for processing certain types of stocks, particularly where it is desired to add coking facilities to existing cracking units which are not properly designed for the cracking of residual stocks.

In this operation, which is termed pre-coking, the entire topped crude goes directly to a once-through coking section which is operated for the production of gasoline and gas oil fractions which may be subsequently cracked in either a single or multiple coil cracking unit.

Because of the ease with which uncracked charging stocks decompose and the difficulty of heating them to extremely high temperatures, it is necessary that the pre-coking operation be conducted at relatively low pressures in order to minimize the temperature drop resulting from cracking in the coke chambers. This limitation precludes operations producing a high degree of coking unless recycling is employed in the coking section. In this case, the coking section becomes substantially an integral coking unit of the type described above.

In a complete pre-coking plant the coking section tower is arrranged for the withdrawal of two gas oil fractions in addition to a furnace distillate sidecut and gasoline overhead. The heavier gas oil fraction which is withdrawn from the bottom of the column is preferably charged to the flash chamber inlet of the cracking section as a safe-guard against the carry-over of dirty stock from the coke chambers. The quantity of this stream may be limited by suitable control of the conditions in the bottom of the coking section tower.

The lighter gas oil stream from the coking section is charged directly to the fractionating column of the cracking plant.

As indicated above, this type operation finds its principal application in conjunction with old type cracking units which are not capable of properly heating residual stocks. It also is desirable for certain charging stocks of high asphaltene content which inherently produce unstable cracked residuums high in sediment content. The asphaltenes from such a stock are deposited in the pre-coking chambers and cause no further trouble when producing high quality cracked fuel oils.

Where only a limited degree of coking is desired, the pre-coking scheme leads to a slightly lower direct equipment cost than that of an external coking plant producing comparable results. However, this saving in equipment cost must be balanced against the relatively limited flexibility of the pre-coking scheme and inferior quality of its products.

As pointed out above, the pre-coking plant is not adapted to ultimate coking for the production of maximum gasoline and furnace distillate yields, such as indicated in columns 1 and 2 of Table 2. Furthermore, it is not capable of a one hundred percent fuel oil operation which will equal the yields shown in Table 1. The external coking plant, on the other hand, is capable of operating at both of these extremes.

TABLE 3

Yields From Pre-Coking and Cracking 25° A.P.I. Mid-Continent Reduced Crude

	Maximum Gasoline	Maximum Furnace Dist.
Percent by Volume of Charge:		
Gasoline, 400 E.P., 10 RVP	65	34
Furnace Distillate	..	44
Fuel Oil (200 S.F.S. at 122° F.)	18	12
Liquid Volume Loss	17	10
Coke, lbs., per bbl	24	24
Gas, cu. ft., per bbl	690	360
Octane Number (A.S.T.M.)	65–66	63–64
Percent Catalytic Polymer Gasoline, 10 RVP	5.5	3.5
Percent Total Gasoline including Polymer	70.5	37.5
Octane Number of Total Gasoline	67–68	66–67

In Table 3 are shown the yields obtainable in the pre-coking and cracking of the 25° A.P.I. Mid-Continent reduced crude previously considered. In column 1, the operation is for the production of coke, fuel oil, and gasoline. In the second column, a maximum furnace distillate cut is withdrawn.

Consideration of Table 3 shows that the pre-coking operation is capable of producing a larger furnace distillate fraction than is obtained in external coking. The fuel oil is a highly dehydrogenated material of low cold test and excellent solvent properties. However, the octane number of the gasoline is three to four points lower than that produced in the external coking operation.

The low octane number of the gasoline formed in pre-coking results from the large proportion of the total gasoline which is formed in the initial coking step. This operation must be conducted with a low overall time-temperature effect because of the ease with which heavy uncracked stocks decompose in once-through cracking. These relatively mild cracking conditions result in a gasoline of low volatility and poor octane number, but with a corresponding reduction in gas production.

A further problem is encountered when processing high sulphur stocks by pre-coking in that the sulphur content of the gasoline produced in the once-through coking of the charge tends to be very high. A West Texas reduced crude when coked in this manner produced coke plant gasoline containing 0.75 percent sulphur, whereas when the same stock was cracked in an external type coking plant the sulphur content of the gasoline was 0.22 percent.

If suitable reforming equipment is provided to raise the octane number or reduce the sulphur content of the coking section gasoline to equal the overall properties obtained in external coking, the advantage of lower equipment cost of the pre-coking scheme is greatly reduced or entirely lost.

COKE REMOVAL

Three methods are in successful commercial application for the removal of coke from chambers. These

may be termed the cable, the rotary drill, and the hydraulic methods.

The cable method employs a steel cable which is hung in the chamber in carefully arranged flat spirals. After the chamber is filled, the bottom head is opened and the cable pulled with a winch, breaking and cutting the coke into lumps which are discharged through the bottom manway.

This method has been extensively applied and developed to an amazing degree of effectiveness. Well organized crews are able to completely clean and reassemble a 10- by 40-foot chamber by this method in from seven to nine hours. A 13- by 50-foot chamber can be cleaned and re-headed in twelve to fifteen hours.

The cable method of clean-out has two advantages which merit its consideration. The installation costs of cable cleaning equipment are substantially lower than those of the other two methods. This is an important consideration where only periodic operation of coking equipment is contemplated. A second advantage is the production of a large proportion of lump coke which ordinarily commands a premium price.

Offsetting these advantages of the cable method are the disadvantages of a relatively high labor and operating cost, together with the problem of inclusion of wire in the coke. The working conditions imposed are also very severe, and particularly undesirable in tropical climates.

In the rotary drill method of coke removal a drill stem is extended upward into the chamber and coke removed in a succession of boring operations. This method has the advantage of relatively low operating costs, desirable working conditions, and rapid cleaning. The boring operation itself can be completed in two to three hours on a 10- by 40-foot chamber.

The principal disadvantages of the rotary drill system are the high proportion of coke fines produced, the high initial installation cost, and relatively high maintenance costs. In addition, the use of this equipment limits the size of the coke chamber which may be employed. Satisfactory operation of rotary drills has not been demonstrated in coke chambers larger than 10 by 40 feet.

The recently developed hydraulic method of coke removal promises to supercede the other two methods in a majority of installations. This method which was the subject of a paper presented by W. F. Court before the American Petroleum Institute, removes the coke by the cutting action of high pressure water jets. Refiner, Vol. 17, No. 11, November, 1938, Hydraulic Decoking of Coke Chambers, Page 568.

The hydraulic method has the advantage of low operating cost, the production of a large proportion of lump coke, short cleaning time, and desirable working conditions.

MARKETING OF COKE

As previously pointed out, petroleum coke is a fuel of superior properties for many applications, and for which many special markets have been developed at premium prices. With an external type coking unit, it is possible to vary the quality of the coke over wide ranges to meet particular marketing requirements. The volatile content may be varied in the range of approximately 6 percent to 15 percent, and a considerable variation in density is possible where desired. Depending to some extent on its volatile content, the heating value of petroleum coke averages approximately 16,200 B.t.u. per pound. Its ash content is ordinarily negligible.

In many localities it has been possible by intensive sales activities to create desirable markets for considerable quantities of petroleum coke. One of the largest coke producers in the country depends almost entirely on an industrial and domestic market which has been gradually developed in a single large northern city. A southern refiner has a well-established outlet for most of his production for use in the drying of tobacco. Other refiners report a good market in the cement industry where pulverized coke is used for firing kilns.

Pulverized coke is an excellent power plant fuel, and is used by many refiners in their own power plants while others have obtained favorable contracts with large public utility plants.

Much further progress is possible along these lines of educating the consumer to the advantages of petroleum coke and developing markets heretofore overlooked. With this situation constantly improving, it appears inevitable that coking will play an increasingly important part in balancing the refinery operations of the future.

Operation Betterments Characterize

Lisbon Plant

FIRST operating in August, 1931, Plant No. 1 of Lisbon Gasoline Company is approaching the end of its seventh successful year, processing not only the gas directly tied in to its own gathering system, but also distilling all the oil passing through the high-pressure absorbers at the smaller and more typically field plant of the company, located just west of Carlisle.

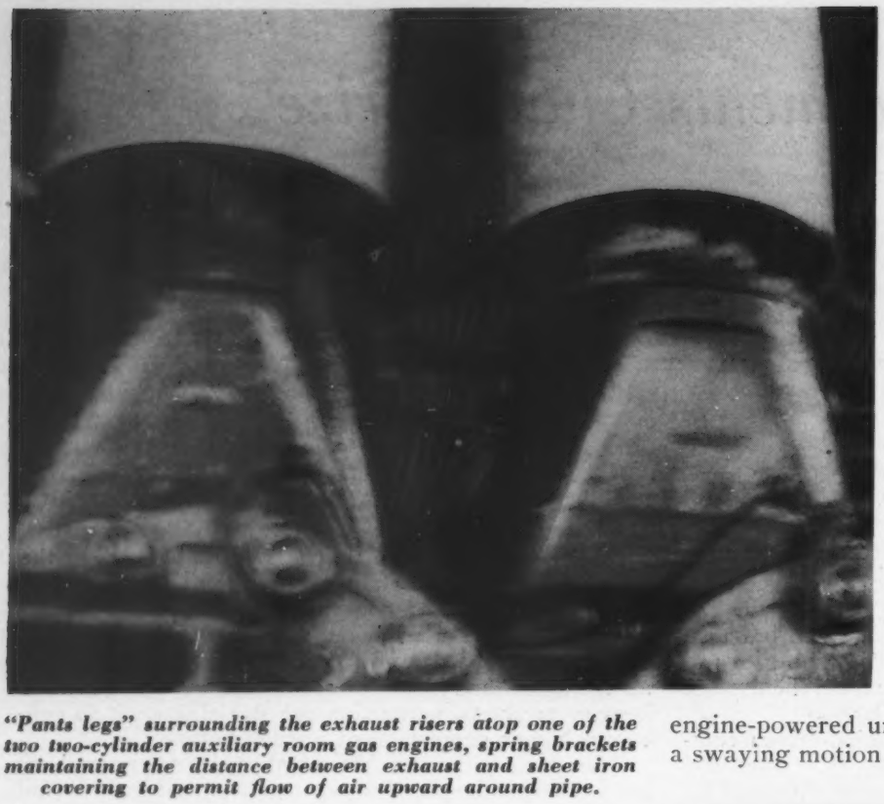
Originally equipped with 13 gas-engine-driven compressors of the usual horizontal type, this plant has added but 3 more compressor units to give a total of 16, the seventeenth unit in the line being a V-type engine with horizontal compression cylinders. Other major units added during the period include a fourth boiler, supplementing the three initially built. It, like the others, is gas fired, and can be run as a unit, or in tandem with the other steam generating equipment.

Processing of the entire volume of raw gasoline from Plant No. 1, as well as that recovered by cooling the gas before it enters the absorbers at the Grisson or No. 2 plant it is pumped continuously to a primary fractionator, butane, iso-butane and propane being condensed as overhead products. In this process practically all the iso-butane is cut from the remaining butane and heavier products, permitting the stable product to contain a higher percentage of normal butane.

The composition of the product is determined by market demand, special provisions being made to permit the loading of butane at the loading rack to trucks, or to pump the material into the line for delivery to the 8-inch East Texas-Gulf Coast gasoline line operated by Humble Oil & Refining Company.

In the storage of finished products the present plant shows more and greater change than in actual processing, two spherical tanks, each of 1501 barrels capacity,

Carrying a spiral-welded line, this span carries the gas main high above the lowered roadway, and eliminates an expensive road-crossing job with the consequent formation of a liquid trap in the sag.



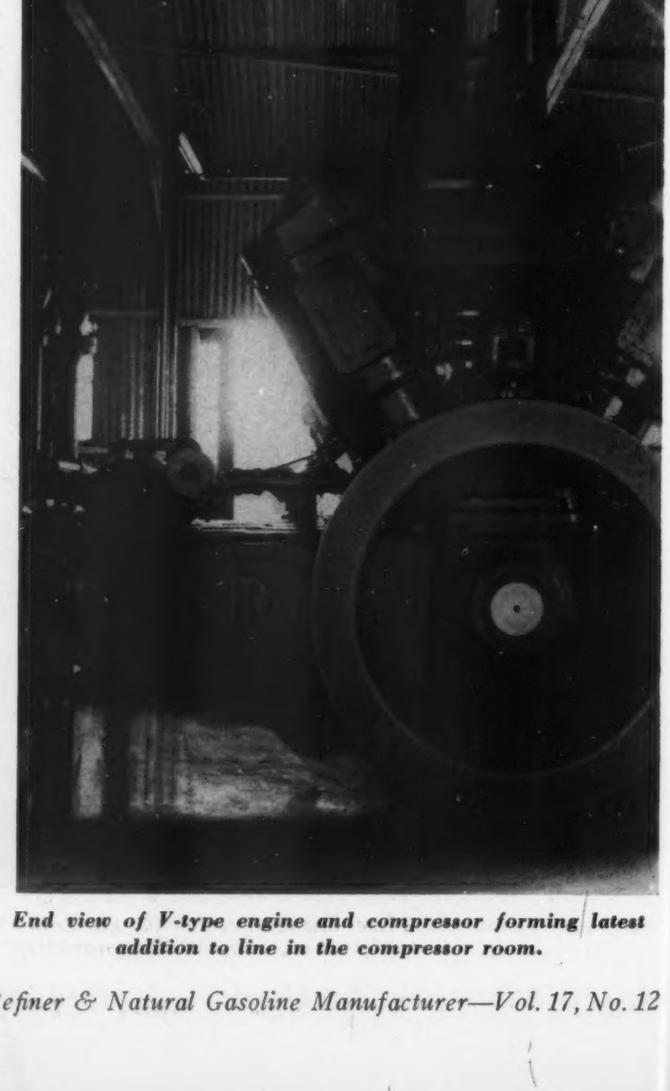
"Pants legs" surrounding the exhaust risers atop one of the two two-cylinder auxiliary room gas engines, spring brackets maintaining the distance between exhaust and sheet iron covering to permit flow of air upward around pipe.

having been erected early in 1937. Largely on the showing made by these two units, a larger tank of the same design but with a nominal capacity of 5000 barrels, was erected late in April, 1938, and is to supersede largely the use of horizontal, cylindrical tanks, for the storage of butane, propane and gasoline, manifold connections allowing any of the three spherical tanks to be tied in to any line, and used as desired. For the handling of fluids to these three tanks no additional pump capacity was required, discharge lines being tied in to others already laid.

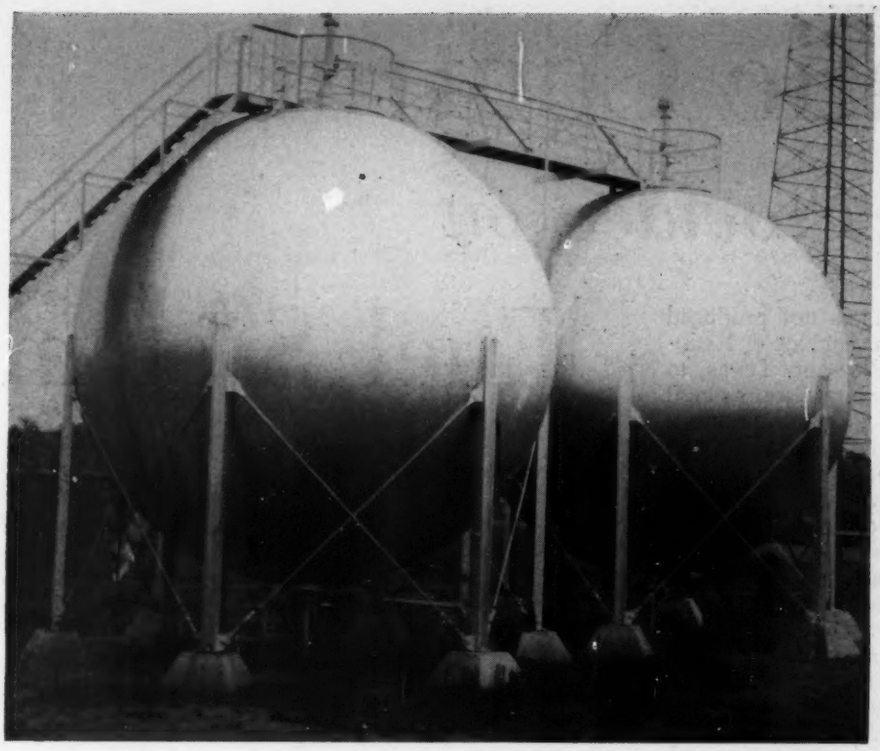
Operating steadily for nearly seven years, the plant is marked more by minor refinements in operation; "kinks" which save time, effort or product, or which simplify supervision of operation processes are most noticeable. Comfort and improved working conditions also are highly regarded, as such extensive changes as the jacketing of exposed exhaust lines from all gas engines indicates.

Formerly carried to the roof, or out the side wall of the engine-room structure to externally mounted mufflers, the exposed exhaust pipes were a source of excessive heat. To curtail this as much as possible, all exhaust lines are led through the roof, to mufflers mounted atop the building, and sheet iron "pants" were erected which slip over the exhaust, allowing an annular space of two inches between pipe and jacket, with the lower end supported some three inches above the flange of the exhaust. Opening through the roof, and shielded from rain by a collar on the exhaust at that point, this annular space acts as a hot-air duct which greatly aids in maintaining engine-room ventilation, and which carries air volume sufficient to keep the sheet-iron jacket cool enough to touch. Applied first to the two two-cylinder units powering the auxiliary room, these "pants" are now used on all exhaust lines in the plant.

Another engine-room kink which reduces to less than one-fourth its former volume the purchase of light bulbs is the suspension of all conduits within this building—of the usual sheet iron and structural shapes construction—using as suspending means ordinary screen door springs, looped around conduit and over the roof truss member. That such buildings are subjected to extensive vibration is evident from the illustration showing one of these spring suspenders, the photograph being taken with a camera resting on a support insulated from the building, with an exposure time of 1½ seconds. The amplitude of vibration of the roof structure is plainly evident in the view, and may be seen as several times that of the suspended conduit. Since the conduit is at no place rigidly tied to the building, the jarring vibration of the gas-engine-powered units is converted by the springs to a swaying motion which is largely neutralized by the



End view of V-type engine and compressor forming latest addition to line in the compressor room.



Two 1,501-barrel spherical tanks formed initial installation of this type of pressure container at the Lisbon plant, effecting marked reduction in evaporation losses of highly volatile products.

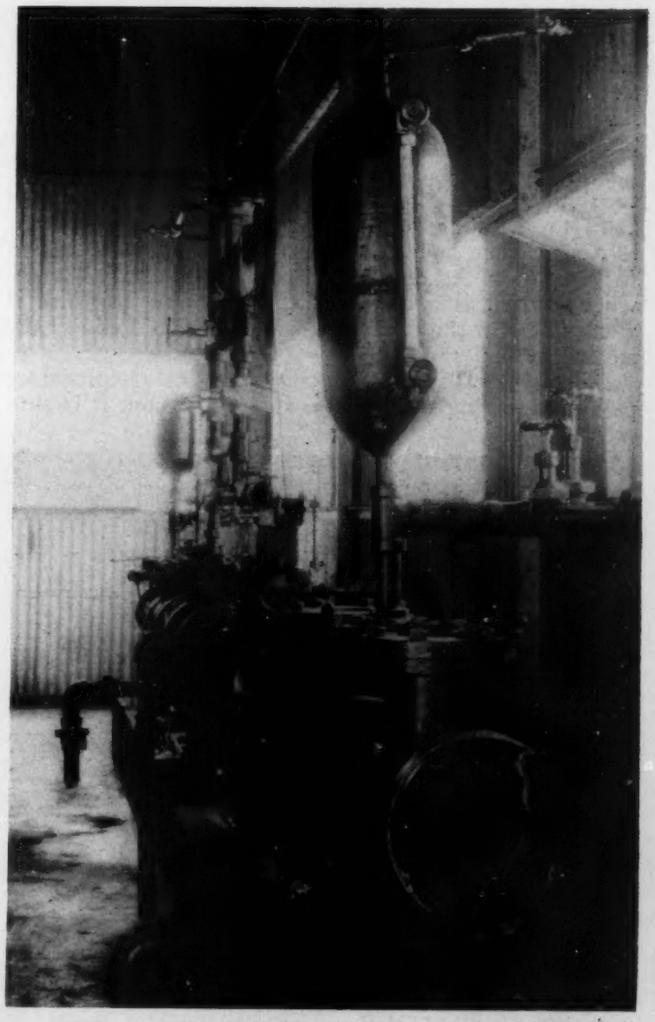
recurring impacts from the engines, and which has none of the sharp jarring nature which formerly resulted in top-heavy bulb replacement orders.

In the boiler room, earlier breakage of feed water lines at the boiler nipples, as well as more uniform feed of water to the boilers, is secured by interposing a welded air-bottle or surge chamber above the discharge line from pumps to boilers, and by carrying within this surge chamber sufficient high-pressure air to insure that the diaphragm of the water control is acted upon only by air. This hook-up entirely suppressed the water-hammer formerly encountered at certain speeds of pump and water demand by the boilers, reducing the upkeep of feed-water lines to a minimum.

Two feed-water pumps are provided, one being kept as stand-by in case of trouble with the other, but the two discharge lines are tied in so that but one surge-chamber line and consequent connection to the water regulator is required. The only manual attendance required by the device is to maintain the proper air-water level within the surge chamber, the water surface absorbing considerable air at the working pressure carried. This air supply is drawn fom the main supplying the plant with high-pressure air for other needs, a sight-glass on the surge chamber permitting accurate control of the level.

Built atop a ridge in the rolling country characterizing the southern end of the East Texas field, the Lisbon plant was faced with a serious job of line lowering when the county highway forces relocated a main highway just outside the plant and made a 16-foot cut under the line connecting Plant No. 1 with the smaller unit. To lower this main the required distance would require trenching well out into the plant yard, with the added disadvantage that when lowered the line would form a sag which would bring added difficulty in the continual collecting of heavier products in the depressed section, requiring provision of means for draining, together with provision of access to the line for this work.

Rather than undertake this added work, the line was raised slightly above the former "skyline" of the ridge along which it was laid, and carried high over the concrete of the roadway on a light but adequate steel truss bridge, spanning the highway and the entry to the plant grounds with ample clearance for any traffic which would pass below the customary elevated traffic lights.



Surge chamber and air line connections to protect diaphragm controlling feed water flow to boilers.

Automatic Control *Provided on* Fuel System

DUE to the fact that process gas is not produced in sufficient quantities in Talco Asphalt & Refining Company's Dubbs unit at Mt. Pleasant, Texas, to satisfy fuel requirements for the several heaters and boilers in the plant, fuel oil is used to generate steam and to operate the straight-run, cracking and reforming furnaces. Two pumps are installed for this purpose; one of which is operated with electricity obtained from a generating plant in the refinery, and the other, a steam-driven reciprocating unit that operates as a stand-by, and functions if and when current fails for any reason.

These two pumps are installed beside the boiler walls, beneath an overhanging steel walk-way which serves as a roof for the units, placed side by side and controlled by automatic instruments. The system used is the full pressure circulating flow ordinarily found in plants that use fuel oil, with excess fuel recycled to storage but held at constant predetermined pressure. The discharge control instrument installed on the motor-driven centrifugal pump operates as a back-pressure unit so that the discharge of this pump is slightly higher than that of the steam pump. Service line pressure is controlled by an additional unit which regulates the pressure on the fuel line, and which is slightly lower than the discharge of the centrifugal pump.

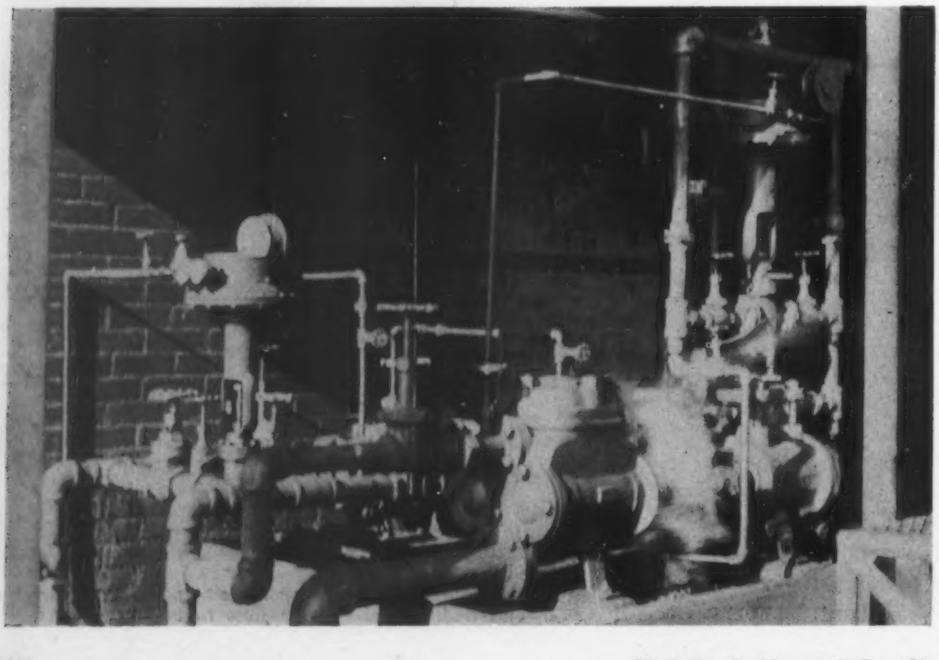
The piping of the two pumps is connected to the suction and discharge of each unit with adequate control gates to facilitate repairs and maintenance. These are left open when both pumps are in mechanical condition for operation. As the electric pump is used at all times when current is available, the supply line pressure is always against the discharge side of the fluid end of the steam pump.

Steam is available for operation of the reciprocating pump by leaving the throttle valve open, but it is shut off from use in the steam chest by a second automatic instrument installed on the piping near the unit, and kept closed by the pressure of the discharge of the electric pump through proper piping to the control head. A bleeder is installed on the steam piping and on the drain cocks of the steam end of the reciprocating pump to admit sufficient steam from the service header to keep condensation removed and the steam end hot.

Without attention of the boiler fireman, or adjustments by anyone, the fuel is maintained at proper pressure and with sufficient volume for furnace requirements. And with the operation of the automatic instruments the required differential pressure is maintained on both the electric unit and the steam-driven pump. Should the electric power be interrupted and the motor-driven pump pressure drop below the predetermined point at which the reciprocating pump operates, the instrument on the steam piping opens to allow steam to drive the steam pump maintaining the required supply of fuel.

As soon as current is available for motor operation, the fireman needs only to throw the switch that is installed on the control wiring of the centrifugal unit and when discharge pressure of that unit rises to normal, the instrument on the steam pump shuts off the steam.

The two units are located as closely to each other as practicable, in order that piping may be reduced to a minimum, and that the drop in pressure between the discharge of one pump to the other will be low. The hook-up was made shortly after the refinery was started in operation during the summer of 1937, and the instruments have never failed to function. Operators on the plant have intentionally opened the switch controlling the electric motor a sufficient number of times that they are confident that the flow of fuel will not fail when current is not available.



Pumps used to handle fuel for boilers and furnaces. Electric unit operates continuously, but steam stand-by in readiness to pick up load if and when power is interrupted without loss of time.

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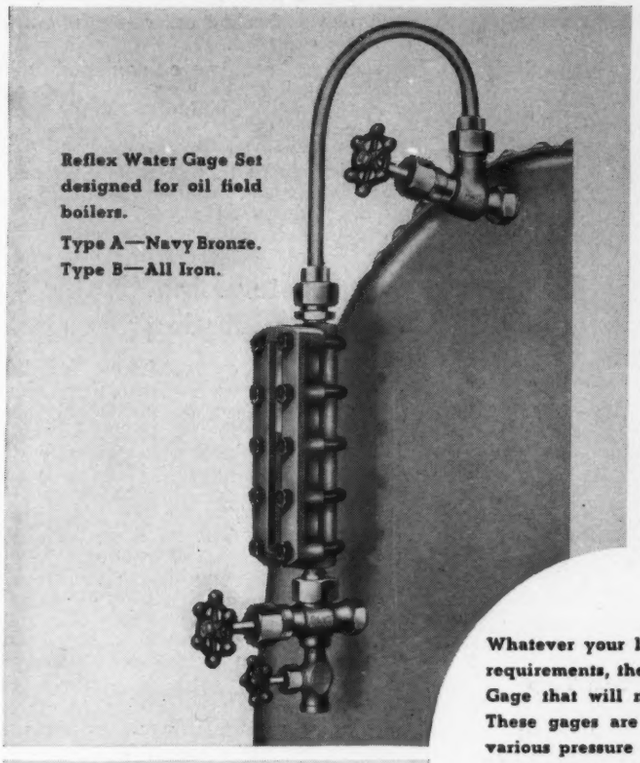

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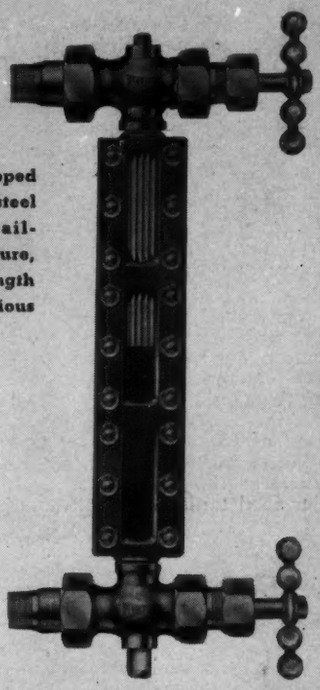

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Navy Type Gage
Extra Heavy Bronze

All Iron Gage
Extra Heavy

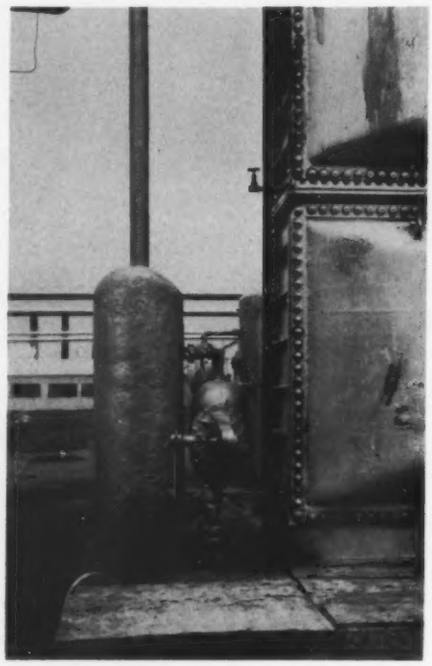
PENBERTHY INJECTOR COMPANY

Manufacturers of QUALITY PRODUCTS Since 1886
DETROIT, MICH. • Canadian Plant, Windsor, Ont.

IDEAS to help plant efficiency . . .

Preheater Steam Trap

IN order to increase the over-all efficiency of a preheater in Fairfax gasoline plant, Skelly Oil Company installed an outside float box and control valve on the condensate side. The original installation included a steam trap some distance from the ground, as the preheater is stacked over two or three exchangers. The new set-up was made by using an accumulation vessel, made of 16-inch pipe about 4 feet in length, connected to the drain line from the preheater at one point, and to a float-controlled valve at another. An outside float box connected to the side of this chamber maintains a constant level of condensate under steam header pressure without fluctuation and possible drainage of the liquid seal. It is stated that since this installation was made, the operation of the oil preheater was noticeably improved, requires no attention, and delivers the condensate back to the boiler feed tank in a continuous stream.



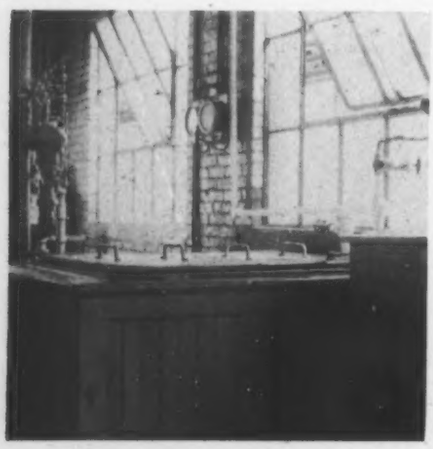
Preheater Steam Trap

Propane Refrigerator For Samples

IN order to obtain constant cooling for samples placed in storage for future testing, employes of The Pure Oil Company at the Toledo, Ohio, refinery, constructed a propane refrigeration coil in the laboratory ice box to supplant cooling formerly obtained with ice. The routine testing laboratory is located near the vapor recovery unit, so that it was an easy task to run a supply line from propane tankage to the laboratory.

A coil made of 1-inch pipe is located in the bottom of the sample storage box with a needle valve placed at a convenient point for controlling the flow of liquid propane to the coil. A ¾-inch line leads from the exhaust end of the refrigeration coil to the compressor intake, to supply the correct amount of vacuum on the coil to promote rapid refrigeration.

As the plant is operated continuously, there is no difficulty in maintaining just the right degree of cooling in the box at all times. Once adjusted, the needle valve requires no attention except at remote intervals, or, when more refrigeration is desired. Where propane is available, and at most plants there is an ample supply in the overhead reflux condenser accumulator tank, the constant cooling obtained with this type of refrigeration is superior to ice.



Propane Refrigerator

Piping Vibration Eliminated

A WALL-WASHING line in McMurray Refining Company's plant at Tyler, Texas, showed considerable vibration shortly after the cracking plant was built, but was relieved of this annoying feature by supporting the pipe near the ground with a coil spring.

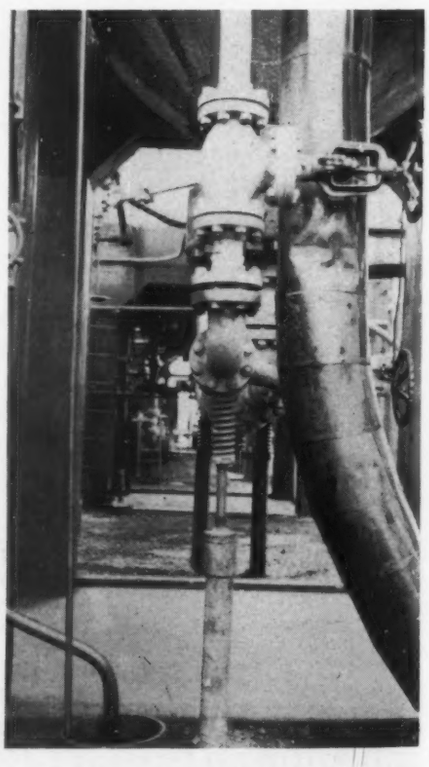
To install the spring support, a two-inch pipe was imbedded in concrete beneath the line, with a heavy nut welded in the upper end. A threaded rod was inserted in the nut with a heavy boss welded near the central part upon which a heavy helical spring was placed. A saddle was placed beneath the piping, with a protruding knob to prevent the spring from slipping away from the point of contact. To take up the strain of the pipe upon the spring, the threaded rod was backed out of the nut until vibration ceased.

Larger lines were equipped with double springs, each set on a separate post, but with a common saddle across the underside of the line being supported. Several of these supports have been in use in this plant for almost a year, without replacement, and the supporting lines are free of vibration.

Air Starter Line Cooler Stops "Bumping"

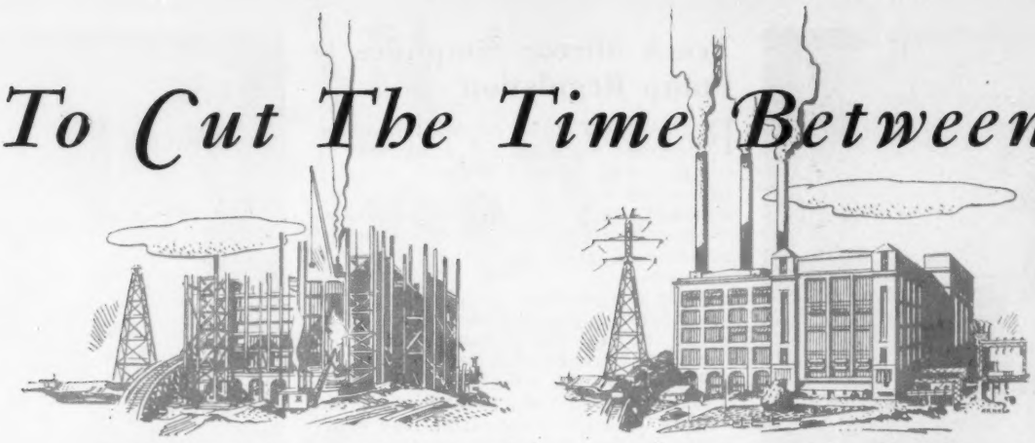
HAVING encountered annoying difficulties due to overheating of air starter piping inserted in the firing head of older type gas engines, which tends to create pre-ignition, Devonian Oil Company employes devised a water cooler for the line that has prevented this difficulty. The air line is half-inch in diameter and fitted directly in the head of the engine. The starting valve is located between this connection and the air supply, which permits hot gases from combustion to gradually flow into the nipple and create a situation similar to a hot tube on a different type engine.

The cooler consists of a three-inch jacket surrounding the vertical section of piping near the insert nipple with water lines connected which are fitted



Eliminates Piping Vibration

To Cut The Time Between



INVESTMENT *and* RETURN

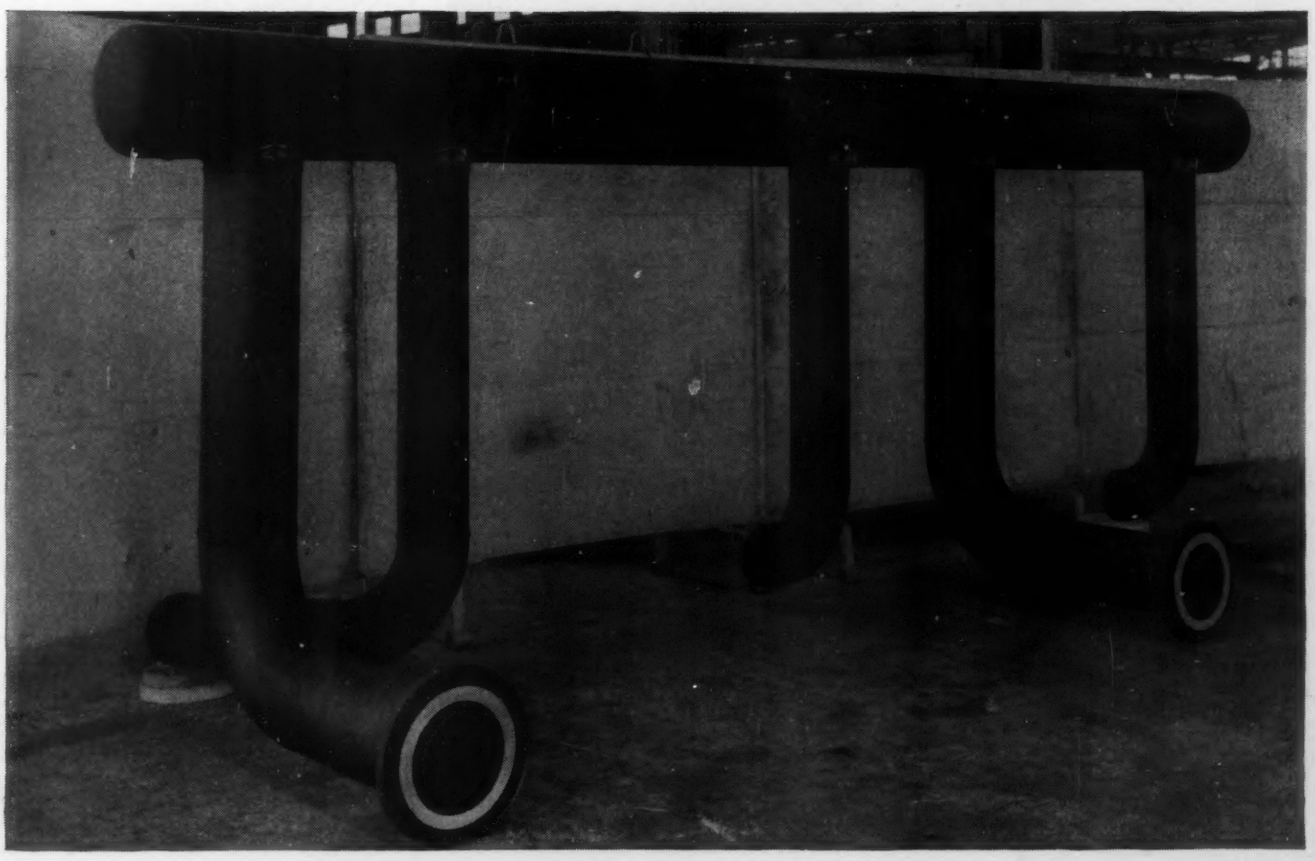
Once the plans are approved, the materials specified and construction begun on your new power plant or process lines, *every day counts.* Your new installation will be more efficient, will return larger profits than the old one — *but not until it is in operation!*

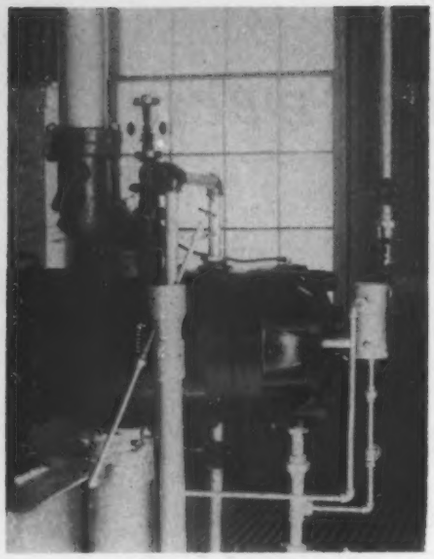
Grinnell Prefabrication provides a sound, tested short-cut to quick erection. Accurate sub-assemblies, prefabricated to specifications, are easily and economically field-welded into a finished piping system, ready for use.

Grinnell's advanced plant facilities, strategically located for service to the East, Central, South and Western parts of the continent . . . Ability to interpret ideas and plans into piping . . . Qualified welders and experienced shop men are among the reasons why it pays to "Give the plans to Grinnell!" Grinnell Co., Inc., Executive Offices, Providence, R. I., Branch offices in principal cities.

PREFABRICATION BY GRINNELL

WHENEVER PIPING IS INVOLVED





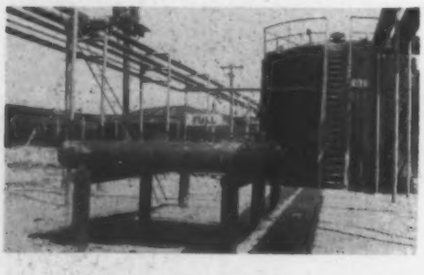
Air Starter Line Cooler

to the jacket and head cooling supply. Water in any desired quantity may be directed through the pipe cooler, and since the installation has been made, no difficulty has been experienced with pre-ignition of the engine. So scale may be removed from the pipe cooler, a collar is welded in the lower end, closed with a quarter-inch plug, for draining and washing with acid when jackets are cleaned.

Ammonia Cylinder Storage

WORKING storage facilities have been simplified by Pure Oil Company, Toledo, Ohio, for ammonia cylinders in its refinery in that city. A combination rack is built near the control room of a combination unit with piping arranged somewhat like an ordinary pipe storage rack, with supporting posts anchored in the ground with concrete. The center post on each side extends higher than those on each end of the rack for holding a rod that supports a sign, lettered on one side Full and on the other Empty.

With a little attention paid to racking cylinders, operators are never confused as to their condition, and may instantly select a cylinder to attach to the feeding line that has not previously been used. At the same time the cylinders on the opposite side of the flag are always sure to be exhausted, and can be picked up without confusion by plant trucks when returning for refilling. Obviously the cost of such a working storage rack is of small importance, and the advantages gained by keeping the drums separated may repay the cost of construction many times.



Ammonia Storage

Truck Mirror Simplifies Pump Regulation

REGULATION of cooling-water pressure on each of a battery of engines was secured through a valve controlled from the engine operating platform, each unit having individual coolant pump, provided with the usual pressure gauge atop the discharge chamber.

Since the pressure gauges were used principally to give the engineer a quick check on the performance of each pump, the gauges were set so as to be visible from the operating office—although this arrangement faced the gauges directly away from the platforms of the engines.

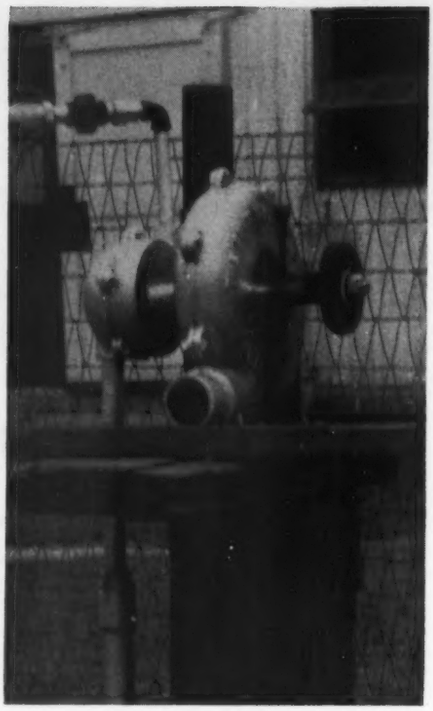
To get around the delay necessary to check pressures when regulating cooling water over any unit, the engineer in charge secured ordinary rear view mirrors, of the type used on motor truck cabs, and installed them so they would

Clamped beside the gauge dial, and canted to permit engine platform pressure readings, this truck mirror saves steps and betters cooling water control

indicate the pressure change to the man on the engine platform. By setting the supporting rod to the side of the gauge dial, it does not interfere with direct reading from the office, while the tilted mirror catches the position of the hand and accurately indicates any change to the man manipulating the water control valve.

Gas-Driven Grinding Wheel

EMPLOYES who wish to sharpen edged tools find it convenient to use a gas driven wheel that one of their fellow employes developed at United Pipe Line Company's Cotton Valley gasoline plant by using parts of first one discarded tool and another. The principal part of this wheel is an old blower, which was designed to operate with steam introduced into a turbine on one end of the shaft, and the second, a corborundum wheel attached to the shaft on the opposite end. The assembly is mounted on a wood post outside the plant fence, connected to a high-pressure gas line, with throttle at hand for operation. The blower case, with fan attached, acts as a balancing

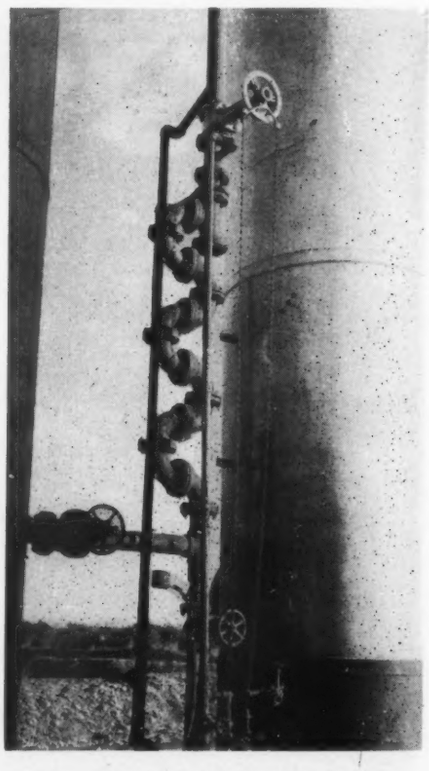


Gas Driven Grinding Wheel

factor, permitting sufficient speed for satisfactory grinding, but retarding the speed so the wheel will not travel at breaking speed.

Auxiliary Contactor For Treating Plant

FOR auxiliary contact of chemicals and cracked gasoline, Independent Refining Company, Laurel, Montana, installed a unit on the outlet of one of the treating tanks



Auxiliary Contactor for Treating Plant

SAFELY SECURED . . .

. . . WITH HIGH-STRENGTH STUDS OF

ALLOY NICKEL STEEL

Typical of applications calling for bolts possessing exceptional strength and toughness, is the head of the large oil refinery pressure vessel here illustrated. The area to be tapped and screwed is restricted, hence, it is desirable to keep the sizes of bolts to a minimum. Yet these bolts must withstand the mechanical stresses associated with the operation of these vessels.

For this purpose, bolts made from an alloy steel containing 1.75 per cent Nickel and 0.50 per cent chromium are employed. They are forged by The Midvale Company, Philadelphia, and heat-treated to provide the optimum combination of strength and toughness.

Consultation on the use of this and other Nickel alloy steels is invited.

THE INTERNATIONAL NICKEL COMPANY, INC., 67 WALL ST., NEW YORK, N. Y.

which has proved satisfactory in operation. The contactor is made by using 11 flanged 4-inch cast iron ells through which the mixture must travel while flowing from tank to tank. Chemicals are added as required at the top of the stack of ells (the direction of travel is downward) to obtain satisfactory reaction, with both chemicals and gasoline entering a second vertical tank. In sampling the gasoline to determine progress of treating, the usual ¼-inch nipple is inserted in the horizontal pipe leading from contactor to tank. To prevent splashing of material, a small drip is installed below sample cock. This is made of 3-inch pipe, attached to a length of ⅜-inch tubing which terminates above the drainage system in the refinery.

Heating Unit for Treating Plant

AS pressure distillate obtained by cracking Talco crude reacts with doctor solution more satisfactorily when its temperature is above 65° F., Talco Asphalt & Refining Company, Mt. Pleasant, Texas, has installed a preheater in the supply line leading to the pumps which handle the product to be treated. The unit is made of 16-inch pipe, about 12 feet in length, filled with 1-inch tubes and steam is used for heating.

The heater is operated only when conditions lower the temperature of the pressure distillate below the required degree, but gasoline flows through the unit whether steam is used or not. It is located beside the pump house where the treater can adjust the amount of steam required when processing the product, and by observing an indicating thermometer, he can be sure of obtaining the desired break in the settling tanks.

Gasoline flows within the shell, around the tubes while steam passes through the tubes in a double pass. Each end of the heater is flanged and bolted for access to the interior, with stay-bolts running the full length of the unit for added strength.

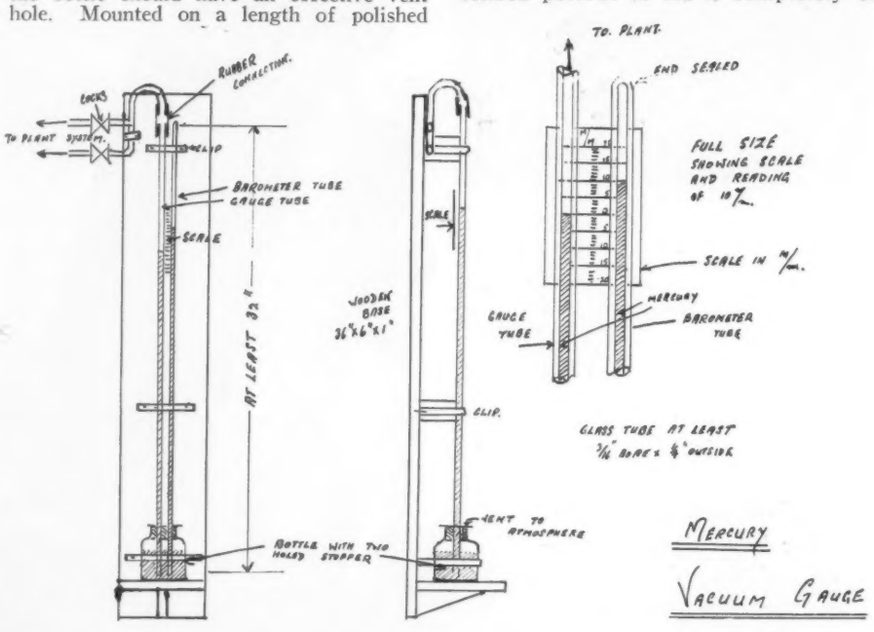
Mercury Vacuum Gauge

A SIMPLE and accurate vacuum gauge can be produced through the use of two heavy gauge glass tubes, some mercury and a small, strong bottle. The tubes are set up as shown in the accompanying sketch. One tube has the upper end closed and it is first filled with mercury to act as a barometer. The other tube is connected in to the plant vacuum system. A simple manifold enables the measurement of vacuum at several points. The reading is taken as the difference between the height of the two mercury columns. A short millimeter scale is set up behind the tubes and if desired a vernier on the scale will give a reading to 7/10 of a millimeter.

A rubber tube connection on the gauge tube should be used to eliminate vibration and breakage. At least 3/16-inch bore tubes should be used to eliminate errors due to capillary action. The stopper on the bottle should have an effective vent hole. Mounted on a length of polished wood, the device makes a useful addition to any plant employing a vacuum system.

R. H. WARBROOK.

Kimmage, Dublin, Erin.



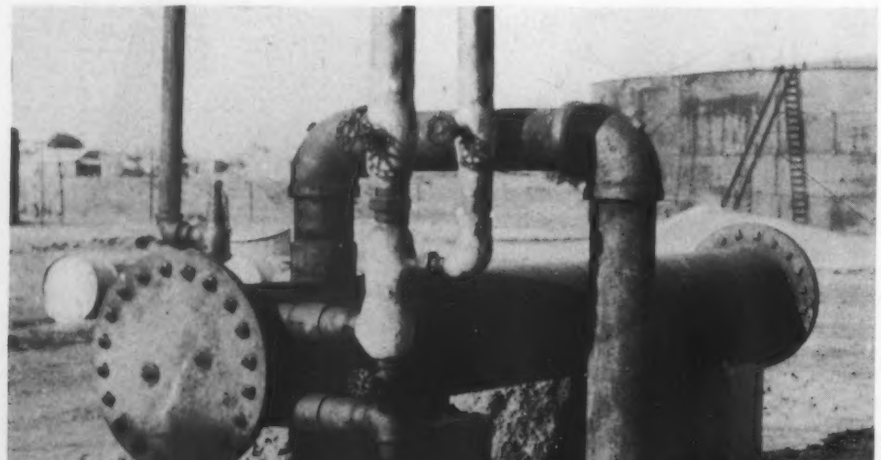
Resetting Solves Sump Pump Problem

AS originally installed, a 10,000-gallon centrifugal pump was supposed to handle all the waste oil from a centrally located sump, lifting the fluid a maximum of 10 feet and discharging against a 50-foot head. Priming of the pump was accomplished through a tie-in between overhead storage tank line and the 4-inch suction from the sump, the pump handling its load satisfactorily after being completely primed.

After having been in service some time, the pump developed priming trouble, having to be worked with for extended periods to rid it completely of air, with frequent "kick-offs" to show that the suction system was either air or gas bound even after satisfactory flow had been established.

Study of the piping showed that the horizontal suction line, of 4-inch pipe, entered the pump house on a level with the center-line of the pump casing, and that the 4-inch was reduced down to 2-inch at the suction entry. This left an elongated space in the suction 4-inch above the point where trapped air or gas must enter the pump to be vented off. And, unless the packing around the pump shaft was kept dead tight, air would find its way into the pump and work back into this space during down time.

To remove the spot favoring air or gas lock, the 4-inch tees on the suction and discharge lines were turned through 90° to permit the reduction from 4- to 2-inch sizes to be made vertically instead of horizontally, as formerly. With this change in piping, it was necessary to block the pump and motor up 9 inches above the original foundation—adding that amount to the suction lift against which the pump must work—but the venting of the suction line was now accomplished in a minimum of time, and the formation of locks while running was eliminated.



Pressure distillate heater to raise temperature of product sufficient that treating is improved during cold months.

Forecast of Demand For December, 1938

THE daily average supply of domestic crude oil estimated by the Bureau of Mines to meet the market demand in December, 1938, is 3,305,800 barrels. This is 85,500 barrels (2.5 percent) less than the estimate for November, and 4 percent lower than the actual demand for domestic crude in December, 1937. The decline from a year ago is due chiefly to the fact that provision is made for an increase of only 3,400,000 barrels in gasoline stocks, compared with an actual increase of 6,164,000 barrels in December, 1937. Ample stocks of distillates and excessive stocks of heavy fuel oils indicate the desirability of reducing runs to a minimum to meet winter heating requirements without an undue increase in gasoline stocks.

Daily average crude-oil production and runs to stills during the four weeks, October 1 to 29, were 3,280,000 barrels and 3,230,000 barrels, respectively. During this period total crude stocks (including heavy crude in California) declined 5,110,000 barrels, 4,980,000 of which was in domestic grades. The daily average withdrawal from domestic grades added to the production gives 3,458,000 barrels as the apparent daily average crude demand, which compares with the bureau's estimate of 3,366,800 barrels daily for October. This apparent excess of 91,000 barrels daily in crude demand was due primarily to larger runs to stills than were estimated by the bureau and resulted in smaller withdrawals from gasoline stocks than were anticipated.

The estimate of motor-fuel demand for December, 1938, is 40,100,000 barrels, less than 2 percent higher than the actual for December, 1937. The composition of this estimate contemplates an improvement in business conditions but a deceleration in the long-time upward trend of gasoline consumption per motor vehicle.

The estimate of motor-fuel exports, reflecting forecasts of exporters, has been lowered from 3,800,000 barrels in November to 3,300,000 barrels in December. This is in line with the usual seasonal drop, caused not only by a decline in demand but also by the closing for the winter of many waterways during December.

Stocks of finished and unfinished gasoline on September 30 totaled 69,086,000 barrels. According to American Petroleum Institute statistics, these stocks declined about 735,000 barrels during October, bringing them to approximately 68,300,000 barrels as of October 31. The bureau estimates an increase of 3,400,000 barrels during December, 1938, compared with an increase of 6,164,000 barrels during December, 1937. Further correction of the present excessive gasoline inventory depends upon reducing runs to a minimum necessary to meet the required distillate production. While current stocks of distillate are considerably higher than last year, they are relatively not much greater than the probable increase in demand. The December estimate of 3,089,700 barrels daily average runs assumes a maximum yield distillate and a substantially greater withdrawal of distillate stocks than occurred in December, 1937.

Benzol and direct sales and losses of natural gasoline have been estimated as 830,000 barrels, making refinery production 45,970,000 barrels. This is distributed among the various districts as follows (thousands of barrels): East Coast, 6,040; Appalachian, 1,610; Indiana-Illinois, 8,060; Oklahoma, 3,060; Kansas-Missouri, 2,540; Texas Inland, 3,210; Texas Gulf Coast, 11,750; Louisiana Gulf Coast, 1,480; North Louisiana-Arkansas, 890; Rocky Mountain, 1,190; California, 6,140.

Natural-gasoline consumption at refineries in December is estimated as 8.3 percent of the total production. The yield of straight-run and cracked gasoline is estimated as 44.0 percent. The application of this yield to the straight-run and cracked production of 42,150,000 barrels gives crude runs of 95,780,000 barrels, or 3,089,700 barrels daily. Foreign crude runs are estimated as 2,100,000 barrels.

The estimate for exports, which was 6,500,000 barrels for November, has been lowered in December, in accordance with forecasts received from the largest exporters, to 5,500,000 barrels. The estimate for crude used for fuel and losses has been increased from 2,600,000 barrels in November to 3,300,000 barrels in December, in anticipation of the usual seasonal change.

The total demand for domestic crude in December, 1938, as indicated by the estimates above, is 102,480,000 barrels, or 3,305,800 barrels daily.

The Look Box

Conventions

1939 JAN. 9–13	Society of Automotive Engineers, Annual Meeting, Detroit, Mich.
FEB. 20–24	12th National Asphalt Conference, auspices The Asphalt Institute, Biltmore Hotel, Los Angeles.

Bureau Issues Final Summary for 1937

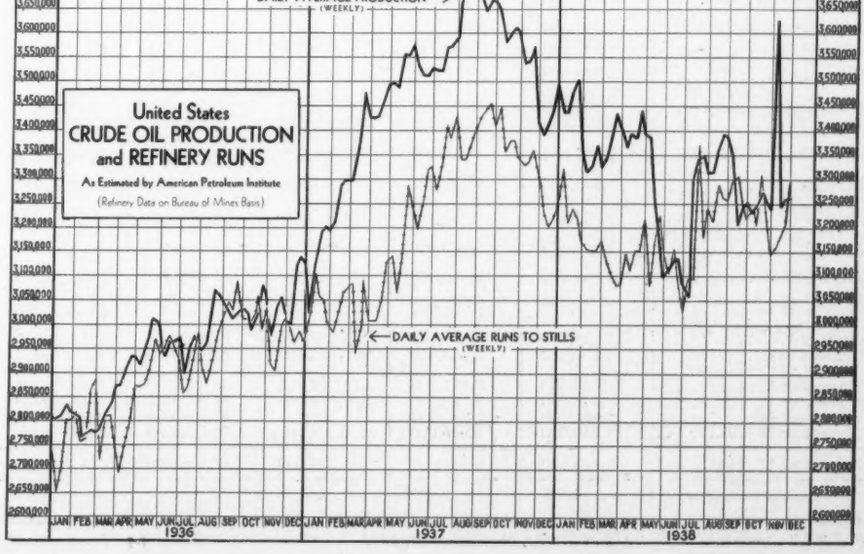
UNITED STATES crude oil production in 1937 reached the record breaking figure of 1,279,160,000 barrels, 16 percent above the previous record of 1,099,687,000 barrels in 1936, it was reported by the Bureau of Mines, November 10 in its final summary for the year.

Natural-gasoline production virtually kept pace with crude output, rising 15 percent to a total of 49,177,000 barrels, the report showed, however, the bureau commented, this was several percent below the record totals of 1929 and 1930, when the practice of maintaining gas/oil ratios as low as practicable was not nearly as general as it is today.

Although benzol production declined rapidly in the last quarter due to shutdowns at steel mills, the total for the year rose to 2,790,000 barrels from 2,502,000 barrels in 1936. Imports of crude, however, declined from 32,327,000 barrels to 27,484,000 barrels, about half of the decrease resulting from labor troubles in Venezuela in January and February.

"From the standpoint of stocks of all oils," the report pointed out, "the record of 1937 was not nearly as favorable as that of the previous year, a decline of about 22,500,000 barrels for 1936 being succeeded by an increase of double that amount. The principal shift affected crude oil stocks, which increased about 18,000,000 barrels in 1937 compared with a decline of about 26,000,000 barrels in 1936."

Most crude oil postings east of California were raised 10 to 12 cents per barrel in the latter part of January, 1937, after which no further changes were made in the year, the bureau



found. The result was that the national average value per barrel rose from $1.09 in 1936 to $1.18 in 1937. Only two states, Michigan and Montana, had a lower average value in 1937 than in 1936. The average production per well per day rose from 8.7 barrels in 1936 to 9.8 barrels last year.

"The maintenance of relatively high prices for crude oil stimulated field work and 22,143 oil wells were completed, or 24 percent more than in 1936," the bureau reported. "The number of producing wells rose to a new peak of 363,030, or 13,580 more than were active the first of the year. That production was relatively more profitable in 1937 is indicated in the figure of net abandonments for that year (8563), which was equivalent to only 39 percent of completions, compared with about 50 percent in 1934, 1935 and 1936.

"Only five states (Kentucky, Ohio, West Virginia, Colorado and Montana), all of small production, had a lower output in 1937 than in 1936. Production in Texas increased nearly 20 percent over 1936 to a new peak of 510,318,000 barrels: Important increases were recorded in Illinois, Kansas and New Mexico. All the major districts of Texas registered gains, but in California and Oklahoma the increases were in 'rest of state,' that is, in the newly developed areas."

Crude runs to stills in 1937 increased 11 percent, rising to a new high of 1,183,440,000 barrels, the bureau found. With ample supplies of crude available, it was pointed out, there was little incentive to increase gasoline yields, and the average declined from 44.1 percent in 1936 to 43.9 percent the following year. The principal change in yields was a gain of about one percent in burner oils and distillates, principally at the expense of residual fuel oil.

"The domestic demand for motor fuel in the first quarter of 1937 was 11 percent above that of the corresponding period of 1936 but by the last quarter of the year the gain had shrunk to three percent," the report commented. "The total for the year of 519,352,000 barrels was eight percent above the 1936 figure. Exports were about a third higher than in 1936, the 1937 total being 38,306,000 barrels. Motor-fuel production in 1937 was geared to a demand at least 10 percent higher than in 1936 and when this did not materialize stocks rose well above the 1936 levels. Thus stocks of gasoline on December 31, 1937, totaled 76,990,000 barrels, or nearly 14,000,000 barrels above the level of the first of the year.

"The annual increase in heating oil demand tapered off in 1937, when the total was about 115,000,000 barrels, or 'only' 15 percent higher than in 1936. The domestic demand for kerosene increased seven percent, probably a reflection of continued gains in the use of range oils. Although the demand for residual fuel oil increased six percent, the demand for the last quarter of 1937 was less than that of 1936, presaging the comparatively poor statistical record so far experienced in 1938."

Revise "Petroleum Facts and Figures"

PUBLICATION of the proposed supplement to the fifth edition of "Petroleum Facts and Figures" has been postponed until early 1939, it has been announced by the American Petroleum Institute. Beginning with the spring of 1939 it is expected that an edition will be issued each year, the spring publication date permitting the presentation of a larger number of later data.

The new supplement will bring the fifth, or 1937, edition up to date, and will include new and additional features.

Indiana Standard Makes Refinery Personnel Shifts

EFFECTIVE January 1, 1939, R. E. Beard, who is at present manager of the Rocky Mountain division refineries of Standard Oil Company of Indiana, will be promoted to manager of the refinery at Sugar Creek, Missouri.

He will succeed G. H. Moffett, who will retire on that date, becoming one of the more than 800 beneficiaries of this company's system of putting employes on annuities after their most active years.

Dr. C. C. Buchler, superintendent of the Casper, Wyoming, refinery, will succeed Beard as manager of the Rocky Mountain refineries, and H. E. Cotton, who has been general foreman of the light oils department at Casper, will move up to the position of superintendent. The changes at Casper will take place December 16.

With his retirement, Moffett will close a career of nearly 43 years in the company's manufacturing department. After an apprenticeship of several years in the Whiting refinery, he was put in charge of the Sugar Creek refinery when it was completed in 1904, and has been continuously in that position in the 34 years since that time.

Beard started at the Whiting refinery in 1920, after doing advanced work at Massachusetts Institute of Technology and serving with several industrial concerns. He was transferred to the staff of the Casper refinery in 1922, and has since worked up through various positions as an operating executive.

Dr. Buchler is a Michigan graduate who joined the laboratory staff at Casper in 1923. He became an operating man in 1930 and has recently been superintendent.

Cotton came to the company on October 1, 1931, after working for Midwest Refining Company. In late years he has been foreman of the light oils department.

Lawrence E. Smith Joins I. P. A. Staff

THE Independent Petroleum Association of America has announced that Lawrence E. Smith will join the staff of the association on November 15 to assist in the development of the Petroleum Research Bureau program suggested in 1937 by the Public Relations Committee, and outlined in greater detail by that committee at the annual convention in Tulsa, October 19, 20, and 21.

"The public should be told of the part the independent producer has played in the development of this industry which produces a product so necessary to the industrial and social life of our nation," the Public Relations Committee said in its recent report.

Smith comes to the association from

Trends of United States Production and Stocks

Figures are from American Petroleum Institute weekly reports, except those on crude stocks, which are from Bureau of Mines weekly reports

WEEK ENDED	Crude Oil Production (Barrels Daily)	Crude Runs to Stills (Barrels Daily)	Crude Oil Stocks (Barrels)	Gasoline Stocks (Barrels)	Gas & Fuel Oil Stocks (Barrels)
September 25, 1937	3,666,300	*3,455,000	307,974,000	65,620,000	116,472,000
October 2	3,647,450	3,400,000	309,036,000	65,266,000	117,076,000
October 30	3,602,950	3,345,000	307,140,000	66,836,000	121,070,000
November 27	3,425,800	3,325,000	304,156,000	68,544,000	121,616,000
December 25	3,492,600	3,245,000	303,294,000	74,437,000	118,659,000
January 1, 1938	3,436,600	3,320,000	303,468,000	77,291,000	118,660,000
January 29	3,357,650	3,170,000	304,286,000	84,844,000	118,793,000
February 26	3,322,800	3,170,000	305,167,000	90,719,000	120,958,000
March 19	3,322,550	3,080,000	306,380,000	*93,192,000	122,067,000
March 26	3,405,600	3,080,000	307,557,000	92,858,000	122,979,000
April 30	3,396,150	3,215,000	307,147,000	91,339,000	128,270,000
May 28	3,098,650	3,150,000	301,583,000	87,946,000	134,315,000
June 25	3,083,900	3,025,000	293,463,000	82,412,000	137,801,000
July 30	3,316,400	3,240,000	288,514,000	76,864,000	144,294,000
August 27	3,388,500	3,255,000	285,029,000	71,754,000	146,926,000
September 24	3,251,150	3,220,000	280,278,000	68,605,000	150,468,000
October 1	3,231,800	3,235,000	280,852,000	68,602,000	151,759,000
October 29	3,237,500	3,145,000	275,824,000	67,590,000	153,719,000
November 5	3,628,550	3,160,000	275,217,000	68,236,000	154,576,000
November 12	3,243,250	3,180,000	273,394,000	67,551,000	*154,666,000
November 19	3,255,800	3,230,000	.....	67,624,000	153,971,000
November 26, 1938	3,260,900	3,295,000	.....	68,628,000	153,634,000
November 27, 1937	3,425,800	3,325,000	†304,324,000	68,544,000	121,616,000
Change in past year	—4.8%	—0.9%	.....	+0.1%	+26.3%

* All time peak. † Stocks, November 20, 1937.

LAWRENCE E. SMITH

long service as a writer on oil. For the past 12 years he has been in charge of editorial work in the Mid-Continent for National Petroleum News. It was in this period that a great part of today's oil industry conservation program has been brought to realization and practically all the effective conservation laws have been enacted by the several states. It was part of Smith's duties to report the development of this program, largely initiated by the independent producers. Incidentally, he was present at the organization meeting of the Independent Petroleum Association of America in June, 1929.

He is native to the Southwest. His father made the historic "run" into the Cherokee Strip in 1893. Thus, he has seen the development of Oklahoma from the days of the sodhouse. He attended the public schools of Oklahoma and the University of Kansas, taught a country school, worked as reporter and editor on several daily newspapers. He served for 16 months in the army during the Great War and in 1920 began writing on oil. He has been engaged continuously in that work to the present.

A wide acquaintance in the industry naturally has been developed by Smith in these years of oil reporting. He has "covered" developments in every producing state of the United States and has visited the producing areas of Canada. He has appeared on the programs of oil associations and technical societies within the oil industry. On some occasions he has addressed these societies in his role of Ellick Botts, the consulting pumper.

New Refrigerating Equipment Standards

EQUIPMENT standards have just been published by the Refrigerating Machinery Association, according to a recent announcement by its Washington office. These equipment standards represent the first of a series to result from the broad standardization program which the association initiated a year or so ago.

The table of contents of the RMA Equipment Standards indicates that Part I deals with ammonia equipment under the following headings: Enclosed Ammonia Compressors, Vertical Open Shell and Tube Ammonia Condensers, Horizontal Closed Shell and Tube Ammonia Condensers, Horizontal Closed Ammonia Shell and Tube Brine Coolers (Flooded), Submerged Open Ammonia Brine Coolers, Ammonia Liquid Receivers, Ammonia Mains, Steel and Wrought Iron Pipe, and Cold Storage Room Insulation.

Part II covers the results of the first studies of Freon equipment, with the following section headings: Low Pressure Condensing Units (Accessories Recommended for Base Units), Freon-12 Condensers (Terminal Difference), and Freon-12 Water Coolers (Mean Temperature Difference).

Important Meetings at Houston Oil Show

FOUR full days will be devoted to papers and discussion on refinery equipment and its application in meeting plant problems during the Oil-World Exposition to be held in Houston from April 24 to 29, inclusive. These technical meetings will be under the direction of the Refinery Committee of which W. H. Curtin is chairman.

The large conference hall on the second floor of the Coliseum seating 300 people will be assigned to the refinery meetings. This room will be equipped with loud speaker, lantern slide projector with screen and whatever other facilities may be necessary.

The complete program has been divided into four sections and one day will be devoted to the subjects to be treated in each section. The meetings will begin at 9 a.m. and adjourn for lunch; reconvene at 1:30 p.m. and adjourn for dinner; and will be continued in the evening from 7:30 to 9:30 p.m. Each section will be under the supervision of a subcommittee with a subchairman in charge of the meetings. The personnel of the committees and subjects to be treated are as follows:

Chemists Program — Tuesday, April 25: K. H. Clough, Sub-Chairman, W. H. Curtin & Company, Inc.; F. W. Jessen, Humble Oil & Refining Company; A. R. Rickards, Sinclair Refining Company; E. W. Gardner, The Texas Company; W. F. Fulton, United Gas Company; and J. H. Tabony, Crown Central Petroleum Corporation.

Instrument Program — Wednesday, April 26: R. L. Mallory, Sub-Chairman, Brown Instrument Company; Joe Peddie, Maintenance Engineering Corporation; L. G. Marsh, Taylor Instrument Company; G. B. Lane, Foxboro Company.

Heavy Equipment Program—Thursday, April 27: M. N. Dannenbaum, Sub-Chairman, M. N. Dannenbaum Company; Joe Miller, Humble Oil & Refining Company; H. M. Stewart, Humble Oil & Refining Company; Philip Darling, Pan American Refining Corporation.

Process Program—Friday, April 28: George Reid, Sub-Chairman, Editor, "The Refiner"; O. E. Berg, Babcock & Wilcox Tube Company; and Karl E. Luger, Carnegie Illinois Steel Company.

Gittings

W. H. CURTIN

Each sub-chairman will have complete responsibility of securing speakers, arranging the program, reviewing papers and arranging for reprints. All programs will be completed and turned over to the exposition management for printing by January 30. The programs will be available for distribution by March 1, but the reprints of papers will not be distributed until after they have been delivered. Subjects of each paper will be announced later.

Announce 1940 Oil Exposition

THE dates for the 1940 International Petroleum Exposition, the world's largest industrial show, at Tulsa, have been set for May 18 to 25, President W. G. Skelly announced recently.

He also said that work on the exposition is already progressing with plans to enlarge and increase the scientific and technical displays in the new Hall of Science building.

Dr. Gustav Egloff, research director of Universal Oil Products Company, again will be chairman of the Scientific and Technical Committee.

As chairman of the committee in 1938, Dr. Egloff was largely responsible for the scientific displays in the new Hall of Science and Industry. He said that his committee will attempt to secure petroleum exhibits from the New York and San Francisco World Fairs. The exposition, held in Tulsa, is rated the largest industrial show of any industry. It is a non-profit institution, owned and controlled, by the industry. The plant covers 20 acres.

Story of Oil in Murals At World's Fair

MILLIONS of visitors to the Petroleum Industry Exhibition at the New York World's Fair in 1939 will see the story of oil portrayed on canvas in four huge murals by the artist William

Tefft Schwarz. The murals, now in the process of completion, are among the largest ever created, covering an area of approximately 7500 square feet.

Considered one of the most interesting art projects of the fair, the basic theme of the paintings will be the development of petroleum products indispensable to modern life through the cooperative efforts of workers, executives and scentists. Each of the canvases will depict one phase of the story of petroleum—production, transportation, research and refining.

The first of the four canvases, each measuring 39 by 48 feet, portrays activities in the oil fields. It shows an oil drill in operation and the workers straining at their various tasks. Outlined in the background are some of the developments made possible by petroleum—streamline trains, airplanes, trucks, tractors, motorships and modern industries.

The second painting tells the story of the tankers that carry oil products to all parts of the world. Pictured in the central scene are workers feeding oil from a tanker to a pipe line, while faintly sketched in are tank cars, oil trucks and other means of oil transport.

Research is the theme of the third composition, which depicts chemists at work in a laboratory. Some of the many ways by which petroleum products make life more comfortable in the home and on the farm are pictured in a vision floating above the scientists.

In the fourth mural are portrayed men at work in a modern refinery with its complex array of dials, registers and controls. Above this scene are outlined towers, tanks, pipes and other equipment used in refining operations.

William Tefft Schwarz (below) and an assistant, putting the finishing touches on an oil derrick in one of four huge murals which will adorn the walls of the Petroleum Industry Exhibition building at the New York World's Fair. Each of the completed canvases will be 39 x 48 feet. The tallest figure shown in the painting is 18 feet high

Golden Gate Petroleum Exhibit Nears Completion

WITH but a few months remaining before the opening of the Golden Gate International Exposition February 18, 1939, construction of the feature exhibit by the Golden Gate Exposition Petroleum Exhibitors, Inc., is reported as progressing rapidly.

Following the signing of a contract with the exposition company by the combined leading oil companies of the west last June, plans have been drawn and construction work on the massive display, largest industrial exhibit at the exposition, was started early in October.

Comprising an area of 40,000 square feet, the comprehensive exhibit will occupy a prominent position in the Vacationland Building, immediately adjacent to the central "Tower of the Sun" which dominates the exposition within the huge "Portrals of the Pacific," main entrance to Treasure Island.

United in their efforts, these western oil companies are spending upwards of $300,000 in creating a combined exhibit, designed to tell the story of petroleum from its inception, its history to the present day and the myriad uses of its many products in this modern age.

The enormous display, laid out in a 200-foot width, will consist of numerous dioramas, housed along each side. Included in the space on the west side will be a model home, wherein the various uses of petroleum products in the home will be emphasized, as well as a spacious theater for presentation of motion pictures, puppet shows and other entertaining features.

Surmounting the dioramas, home exhibit and theater, will be large murals, colorfully portraying scenic views of the west. Two huge murals, 120 feet over-all will cover the closed area at the rear. These depict a modern city, thriving with activity and life in a typical rural area.

To occupy a dominant position at the center of the entire exhibit, will be a model oil derrick, mounted upon a large base. The flood-lighted derrick of aluminum and chrome 25 feet high will be animated by a revolving drill, while the base, 14 feet high, faced with glass and "Lucite," will consist of cascades of oil flowing into pools. Both will be indirectly illuminated. At the corners of the base, tall glass columns, filled with oil will be animated by slowly rising air bubbles.

Outstanding in the petroleum exhibit will be the scale model of a modern refinery, constructed of glass, "Lucite" and metal. Located directly in front of the central derrick display, this novel miniature plant will be completely animated, with all units constantly in operation. It will be built upon a scale of one half inch to the foot, being 36 feet long and 16 feet wide. Here everyone will view the entire operation of a manufacturing plant, with every stage in the process clearly visible.

Other features of the exhibit will cover the comfort and entertainment phase, with ample seating accommodations located throughout the display area.

In planning the petroleum exhibit, the western companies desire to afford the public an opportunity to learn all pertinent facts about petroleum, that they might better appreciate its usefulness in its many forms and thus adapt this usefulness to improvement in industry and home life.

The exhibit will in no way be static. Motion is the keynote throughout and every effort is being made to present the story of petroleum in entertaining, as well as educational manner.

For the purposes of the Golden Gate International Exposition the petroleum industry has eliminated any thought of commercial competition. There will be expressed no element of competitive merchandising and selling as found in the industrial world.

The oil industry of the west thus makes another progressive forward step in offering the public this worthwhile and entertaining feature as its contribution to the success of the Pageant of the Pacific in 1939.

The companies, whose membership qualifies them for representation in this manner, are: General Petroleum Corporation of California, Gilmore Oil Company, Richfield Oil Corporation, Rio Grande Oil, Inc., Seaside Oil Company, Shell Oil Company, Signal Oil Company, Standard Oil Company of California, Sunset Oil Company, The Texas Company (California), Tide Water Associated Oil Company (Associated Division), Union Oil Company of California.

The officers of the corporation are: B. I. Graves, president; H. E. Britzman, H. T. Dodge, F. A. C. Guepin, and W. J. Held, vice presidents; E. A. Hugill, Jr., secretary; A. B. Tanner, assistant secretary; E. A. Hugill, Jr., treasurer; A. B. Tanner, assistant treasurer; Austin L. Black, manager.

B. I. Graves is chairman of the board of directors, which includes H. E. Britzman, W. B. Curtis, H. T. Dodge, A. C. Galbraith, F. A. C. Guepin, W. J. Held, E. A. Hugill, Jr., J. Howard Marshall, and A. B. Tanner.

Petroleum Course Offered by California

CLASSES in petroleum engineering, oil geology, and petroleum technology and kindred subjects will be featured in the new schedule of classes which the University of California Extension Division will open during January and February at its 815 South Hill Street classroom headquarters in downtown Los Angeles, according to Miss Margaret Wotton, executive secretary.

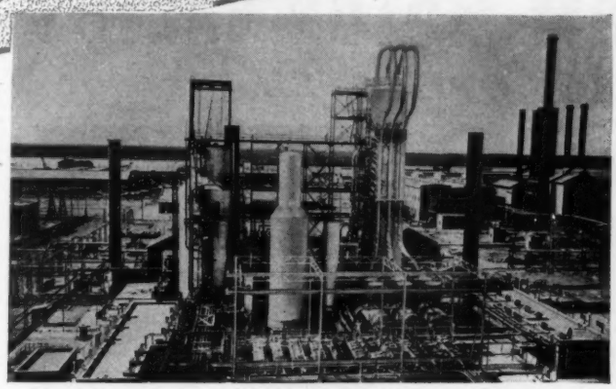
In addition to the petroleum classes, a full program of mathematics courses and classes in engineering drawing, mechanical drawing and similar subjects will be available to everyone interested in enrolling. Instructors in the petroleum courses will include William Woods Porter, Glenn Bowlus, and Paul F. Devine.

British Interests Investigate Turner Valley

BRITISH interests are interested in the oil production in Turner Valley, Canada, as a potential source of supply for the United Kingdom, according to a report to the Department of Commerce from the office of the American Commercial Attache at Ottawa.

These interests have requested re-

VERSATILITY SUGGESTIVE OF ENGINEERING SKILL



One or more of the following plants is now under construction or was recently completed by Badger engineers:

* Solvent Dewaxing Units
* Edleanu Treating Unit
* Topping & Vacuum Unit
* Special Cracking Unit
* Pressure Distillate Rerun Unit
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The above is suggestive of the skilled engineering and workmanship that can be brought to your project.

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Engineers and Contractors
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ports from the Canadian government giving all statistical information regarding oil development in Alberta. The Alberta Petroleum Association has requested the province, through the Conservation Board, to transmit these data. It is intimated that British capital would construct a pipe line from Turner Valley to Vancouver, a distance of 1000 miles from Calgary, the report states.

The Alberta Petroleum Association stated they have been in correspondence with British Admiralty officials concerning the potential supply from the 59 crude wells now in operation which are capable of an output of 50,000 barrels of oil a day, according to the report.

Desalting Crude Petroleum

THE Bureau of Mines has released Report of Investigations No. 3422, "Desalting of Crude Petroleum, a Review of the Literature," which work was done in cooperation with the state of Oklahoma. The authors are L. F. Christianson and Joseph W. Thorne. The report is comprehensive in scope and reviews the various methods employed by the industry for salt removal from crude. References to articles in petroleum literature and patents total 70 and discussion of the more widely used systems and methods are sufficiently complete to be of real value. An attempt is made to point out the various deleterious effects resulting from transporting and refining crude petroleum containing chlorine salts. A resume of the most important types of desalting processes is given. The descriptions of several demulsifying processes are included to stimulate constructive thought for further development of desalting systems.

The review indicates that the removal of salt from petroleum transported by pipe lines or charged to refinery systems is essential for the elimination of corrosion and for the efficient operation of the systems. The study suggests that research on the physical characteristics of brine emulsions and of salt in crude petroleum would be important to the process developer as well as to pipe line and the refinery operators. Results of such research being conducted by the Bureau of Mines will be published later. Copies of R. I. 3422 are available from the Bureau of Mines, Washington, D. C., at no cost.

DIAPHRAGM MOTOR VALVES

PILOT OPERATED

For Refineries and Natural Gasoline Plants

SMOOTH operation . . . sensitive action . . . and rugged construction are some of the features you will like about Davis' advanced line of Diaphragm Motor Valves for pilot or instrument controlled valve installations. These include both direct and reverse acting types for steam, air, gas, oil, or water lines using pressure, temperature, or liquid level as the controlling factor. Standard valves are available in bronze, semi-steel, or steel with trim of bronze, nickel iron, monel or stainless steel. Chrome alloy steel bodies with special alloy trim are available on order. Standard construction features include parabolic, square, or V-ported semi-balanced inner valves, stainless steel stems and ball bearing adjustment nuts.

No. 14B, illustrated at the right, is designed for either indoor or outdoor installation. In addition to features mentioned above, all moving parts are completely enclosed. Ball bearing stem guides reduce friction to a minimum. Valve stem lubricator and valve position indicator are regularly furnished. Your request for information and quotations will receive prompt attention. Catalog on request.

●

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●

DAVIS REGULATOR COMPANY

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Butane-Propane Gases Handbook Revised

THE second edition of the Handbook of Butane-Propane Gases, originally issued in 1935, has been reprinted, revised and enlarged as of the late fall of 1938, and the new edition comprised of 411 pages is again crammed in important and valuable engineering data covering the liquefied petroleum gases industry in all its various phases from manufacture to the final user. Many of the original articles reprinted in this edition have been revised and brought down to date, much of the engineering information in tabular from has been enlarged upon, and several new chapters have been added. New material discusses for example the operation of a metropolitan bus system on butane fuel, a combination central plant for supplying a complete utility service, and semi-bulk distribution. Changes which have been made in the National Board of Fire Underwriters Regulations for Liquefied Petroleum Gases are published to supplant those dated July, 1934. In addition to covering internal combustion engine use, and the manufacture and physical properties of the refinery-produced liquefied gases, the reprinted edition presents significant material on pressure vessels, temperature-volume correction factors, competitive fuel data, tables of thermodynamic properties, tests and analysis and specifications, analytical procedures are outlined in detail, and many other phases of this rapidly growing industry. The present hankbook in its technical reference departments, and in its coverage of processes, equipment and operating experience, is now a much more complete product than were the earlier editions. Copies can be secured through the Book Department, Gulf Publishing Company, 3301 Buffalo Drive, Houston, Texas.

Study of Wyoming Black Oils

THE Bureau of Mines released last month Report of Investigations No. 3423 "Chemical and Refining Study of Some Wyoming Black Oils," by H. M. Thorne and Walter Murphy, the work being done in cooperation with the

STEEL FASTENINGS FOR HIGH TEMPERATURES

Up to 1050° F.

SUPERTEMP

Supertemp is a chromium-tungsten steel with high resistance to oxidation, fatigue and creep. To be used for bolts, studs and refinery parts when temperatures up to and including 1050 deg. F. are encountered. On the basis of a 1200 deg. F. draw, the following are guaranteed minimum physicals for a one-inch round bar of Supertemp:

Yield Point ..105,000 lbs. per sq. in.
Tensile Strength, 125,000 lbs. per sq. in.
Elongation .....18 per cent
Reduction .....55 per cent
Izod impact strength at 1000 deg. F. .....25 ft.-lbs.

Up to 925° F.

S. A. E. 4140

A chromium-molybdenum steel for use up to 925 deg. F. Less expensive than Supertemp, but equally effective in this lower-temperature range. On the basis of a 1200 deg. F. draw, the following are guaranteed minimum physicals for a one-inch round bar of 4140:

Yield Point ..100,000 lbs. per sq. in.
Tensile Strength, 120,000 lbs. per sq. in.
Elongation .....18 per cent
Reduction .....55 per cent
Izod impact strength at 900 deg. F. .....35 ft.-lbs.

When drawn at a lower temperature, S. A. E. 4140 shows increased strength and slightly decreased ductility. Drawing to a temperature 150 deg. F. above the maximum service temperature is recommended if the fastening is to keep its original physical properties.

Up to 925° F.

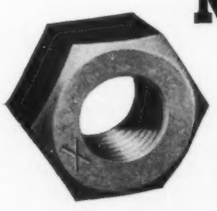
MAYARI "A"

A chromium-nickel steel similar to S. A. E. 3140. To be used in oxidizing atmospheres up to 925 deg. F., where its nickel component makes it highly resistant to scaling. On the basis of a 1200 deg. F. draw, the following are guaranteed minimum physicals for a one-inch round bar of Mayari "A":

Yield Point ...95,000 lbs. per sq. in.
Tensile Strength, 115,000 lbs. per sq. in.
Elongation .....18 per cent
Reduction of area .....55 per cent
Izod impact strength at 900 deg. F. .....40 ft.-lbs.

A stock of steel fastenings for high temperatures, oil quenched and drawn to approximately A. S. T. M. specifications for a Class C material, is available at the Lebanon, Pa., plant for immediate shipment.

Nuts for High-Temperature Fastenings



Bethlehem makes two types of nuts especially recommended for high-temperature service.

The Bethlehem Treated Nut is a semi-finished medium-carbon nut which meets Class 2 of the A. S. T. M. Specification A-194-36T. On test this nut has developed a stripping value of 105,000 lbs. per sq. in. at 1000 deg. F.

Where a higher minimum Brinell than the 160 of the Treated Nut is desired, use the Bethlehem Oil-Quenched Nut. This nut is semi-finished and medium carbon, and easily meets Class 2H Specification with its minimum "as finished" Brinell of 250, and will stand up under the battering of heavy wrenches. Both of these nuts are hot-forged.

We are also prepared to furnish nuts to meet Classes 3 and 4 of the A. S. T. M. Specification A-194-36T.

BETHLEHEM STEEL COMPANY, General Offices: Bethlehem, Pa. *District Offices:* Albany, Atlanta, Baltimore, Boston, Buffalo, Chicago, Cincinnati, Cleveland, Columbus, Dallas, Detroit, Honolulu, Houston, Indianapolis, Johnstown, Pa., Kansas City, Mo., Los Angeles, Milwaukee, Nashville, New Haven, New York, Philadelphia, Pittsburgh, Portland, Ore., St. Louis, St. Paul, Salt Lake City, San Antonio, San Francisco, Savannah, Seattle, Syracuse, Toledo, Tulsa, Washington, Wilkes-Barre, York.
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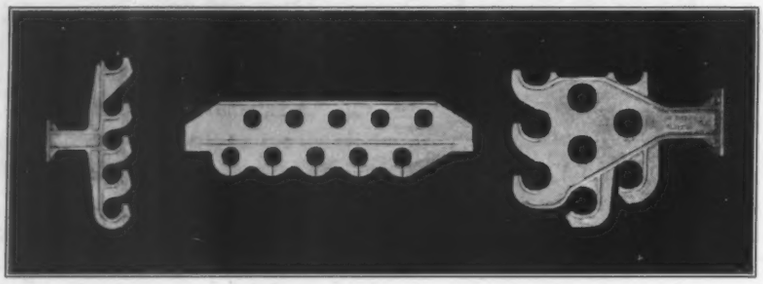
University of Wyoming. In general, these crude oils are characterized by their high sulfur, high asphalt and low gasoline content, and are called black because of these properties and their color. The report points out that whereas the average daily production from black-oil fields of Wyoming during 1937 was slightly more than 13,000 barrels, the estimated potential production from wells now drilled was about 56,000 barrels per day and the production could be increased several times its present volume if markets for this type of crude oil were available.

The present paper is essentially a progress report giving the results of the thermodecomposition or cracking studies so far carried out. The experiments demonstrated that cracking could be successfully done, but it is believed that reducing the crude oil to a penetration asphalt and cracking the intermediate distillates would be more economical, and experimental studies in which asphalts are recovered and intermediate distillates cracked are now in progress. The straight-run naphthas produced by topping black oils usually are deficient in light ends, and they have relatively high sulfur contents and are low in octane number. It is necessary to improve the quality of these naphthas by blending with more volatile, higher octane, lower sulfur content naphthas in sufficient quantities. Also reforming or moderate cracking of the straight-run naphtha and subsequent chemical treatment should improve their quality. Copies of R. I. 3423 are available from the Bureau of Mines at no cost.



DESIGN OF *CALITE TUBE SUPPORTS

FOR HIGH TEMPERATURE, HIGH PRESSURE

BUTANE POLYMERIZATION FURNACE

550 LB. PRESSURE AT 1,050° F.

For the exacting duty of this Thermal Polymerization Furnace, with its extremely high tube temperatures due to vapor phase, tube supports of CALITE B-28 were chosen. While the above illustrations may look "funny," observe that the right-hand wall bracket has been carrying three rows of 5" O.D. x ½" WALL CALORIZED low CHROME MOLLY TUBES on **one** arm — not two, as in the usual design. The saving in metal, and in loss of heat through the furnace wall, is obvious. These supports have been in constant service for more than two years without distortion.

CALITE tube support designs are not based on one or two creep tests of a laboratory sample. At 1800° F., for instance, we have made **nine** creep tests from samples in three commercial heats running at both ends of our carbon range. These were tested at the University of Michigan and check tested at Battelle Memorial Institute. These creep tests all ran 1,000 to 1,600 hours.

Among the leading refinery furnace builders who use CALITE Tube Supports are:

- **ALCO PRODUCTS**
- **FOSTER WHEELER CORPORATION**
- **THE M. W. KELLOGG COMPANY**
- **UNIVERSAL OIL PRODUCTS CO.**

When you build a new furnace or have to replace inferior tube supports specify CALITE — They will outlast the useful life of your furnace.

*Chrome Nickel-Moly Castings of high creep strength (for load carrying) and high residual ductility (to prevent cracking) available **only** in CALITE.

Write today for Bulletin S.O. and complete creep test information

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Modern Highways Make Better Use of Materials

BETTER ways of using the old, established road building materials are a feature highway improvement in this country, according to the United States report to the recent International Road Congress at The Hague, Holland. Old established materials are still used on practically all highways. Improvements are in the materials and in their use. The Bureau of Public Roads of the U.S. Department of Agriculture calls attention to some features of the report:

Increase in speed and volume of traffic have necessitated marked improvements in the width, grade and curvature of highways.

There has been a rapid increase in the use of mechanical vibrators in the placing of concrete. The vibrators operate at high speed and cause the concrete to compact into a denser mass, resulting in greater strengths. Experiments have shown that by using less water in concrete mixtures and by vibrating during finishing operations, the strength of concrete pavements can be increased by as much as 10 percent.

Paving brick are being made stronger and denser by subjecting the mixed clay to a vacuum during manufacture. This process, known as "de-airing," also improves the regularity in shape of the brick. Most paving brick plants in the United States are now equipped to manufacture "de-aired" brick.

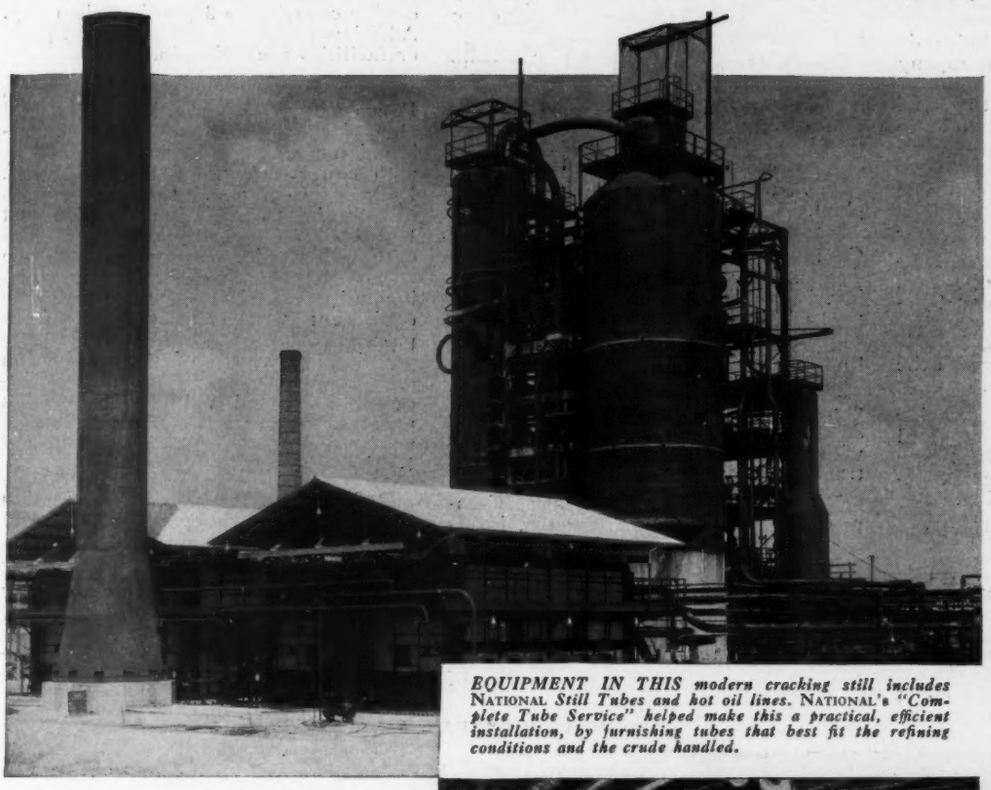
Considerable progress has been made in development and improvement of the low-cost type of bituminous surfaces. Many of the improvements have resulted from the development of better equipment for mixing, placing, and compacting such surfaces.

Highway accidents in the United States have increased alarmingly, says the report, pointing out that four out of five highway accidents occur on dry roads in clear weather and while the car is traveling straight ahead. Recommended measures to reduce accidents include education of drivers, more rigid enforcement of driving regulations, restrictions to prevent unsafe drivers from operating motor vehicles, and elimination of highway conditions that contribute to accidents.

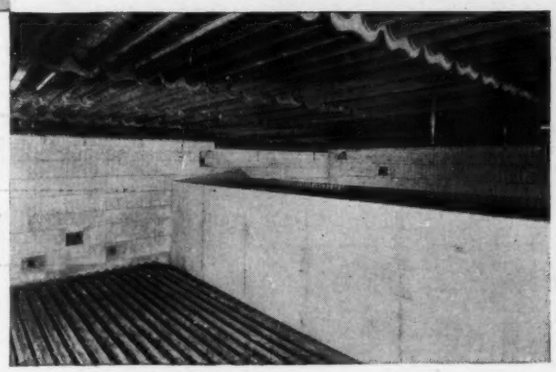
Much of the present highway system was constructed to carry the slow-moving traffic of an earlier day. Unforeseeable increases in vehicle speeds have necessitated great changes in standards of highway design during the past 10 years. The Road Congress report shows that modern traffic requires wider and straighter highways. To facilitate traffic movement and increase safety, it is recommended that four-lane highways have a dividing strip down the center, separating opposing traffic. Sidewalks need to be built along highways carrying much pedestrian traffic.

The surface of "slippery when wet" roads generally is too smooth and becomes slippery because water can cover the surface and act as a lubricant between the road and vehicle tires. The report says this condition is remedied in modern construction by giving the surface a "sandpaper" finish. As the term implies, this finish is somewhat rough but not rough enough to affect riding qualities seriously. Projecting particles, or ridges, afford resistance to skidding and form small channels through which the thin film of surface water is drained off.

"COMPLETE TUBE SERVICE" wins Worldwide Approval



EQUIPMENT IN THIS modern cracking still includes NATIONAL *Still Tubes and hot oil lines.* NATIONAL'S *"Complete Tube Service" helped make this a practical, efficient installation, by furnishing tubes that best fit the refining conditions and the crude handled.*



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1% Cr. ½ Moly. 1¼ Sil.
2% Cr. ½ Moly. 1¼ Sil.
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UNITED STATES STEEL

▼ PLANT ACTIVITIES ▼

Enlarge: Standard Oil Company of Cuba, Belot, Cuba, is remodeling two of its three Tube-and-Tank cracking units, and will use the third as a pipe still unit. The revamping will give combination type of operation. A new vacuum tower for lubricating distillate production is going in.

Modernization: Compania Nativa de Petroles, S.A. (Standard Oil Company of New Jersey) at Campana, Argentina, South America, is reconstructing and enlarging its gasoline recovery and stabilization system and installing lubricating oil dewaxing equipment. An additional boiler and a turbo generator in the power department are contemplated.

Refinery: Standard Oil Company of Venezuela, near Carpito where a 4200-barrel topping plant has been operated, plans a modern refinery with construction to begin shortly. A large viscosity breaker to process about 30,000 barrels a day is to be erected together with the usual type of refinery systems.

Cracking: Compania de Petroleo Lado, La Salina, Venezuela, is reported planning erection of a new tube still and a new cracking unit. Present capacity is about 7000 barrels a day.

Enlarge: Agwi Petroleum Corporation, Ltd., plans to remodel and to enlarge its cracking department at Fawley, England, to secure increased capacity.

Refinery: Sociedada Anonima Concessionaria de Refinicao de Petroleum em Portugal (SACOR) has been formed to build and operate a new refinery at Lisbon, Portugal. The project is backed by "Redeventza," S.A. of Roumania under agreement that the new concern will supply 50 percent of the country's needs. Equipment details not available other than the recently ordered 3500-barrel atmospheric-vacuum distillation unit.

Iso-Octane: Standard Oil Company (Indiana), Whiting, Indiana, is building a large installation for the production of iso-octane, for use in making aviation motor fuels. The M. W. Kellogg Company recently completed a 22-000-barrel combination unit at this plant.

Distillation: Socony-Vacuum Oil Company, in addition to its large Houdry catalytic cracking unit now building, is erecting a topping and vacuum pressed distillate redistillation unit at Paulsboro, New Jersey. Both contracts to E. B. Badger & Sons Company.

Distillation: Atlantic Refining Company, Philadelphia, Pa., is installing a 20,000-barrel crude oil distillation unit, with The Lummus Company as contracting engineers.

Refinery: McColl-Frontenac Company, Calgary, Alberta, Canada, is reported projecting plans for a 2000-barrel cracking and skimming plant, and to have tentative plans for a similar plant at Regina, Saskatchewan.

Poly: Lago Oil and Transport Company (Standard Oil Company of New Jersey) is completing construction of a polymerization unit and hydrogenation system for the production of 100 octane aviation gasoline at Aruba, West Indies. Likewise additional sweetening, redistillation and stabilization equipment are being erected.

Enlarge: United British Oilfields, Point Fortin, Trinidad, is erecting a new crude-oil distillation unit and a gasoline-stabilization system which will double capacity to 34,000 barrels a day. Additional tankage and steam and power facilities are going in.

Cracking: Continental Oil Company, Ponca City, Oklahoma, has announced plans for construction of a new combination cracking unit to cost $1,250,000, with contract awarded to the M. W. Kellogg Company. Construction is scheduled for completion about August 1, 1939. The company will spend another $250,000 for rearrangement of the steam system in revising lines, pumping units, electrical systems and other equipment at the refinery. Some of the present equipment will be remodeled to permit continuance of the production of petroleum coke. This company recently completed a $500,000 extension program at its Denver plant and other work at Artesia, New Mexico, and Baltimore, Maryland.

Refinery: Cumberland Production Company is completing plans for construction of a 3000-barrel cracking plant and refinery near Salem, Illinois. Officials of the concern are J. C. Potter, A. B. Potter, Tom Potter and G. W. Johnson.

Sale: West Texas Refining Company which formerly operated the refinery at

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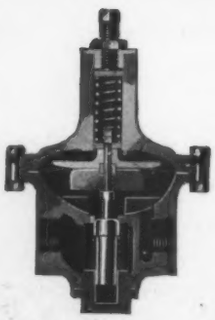

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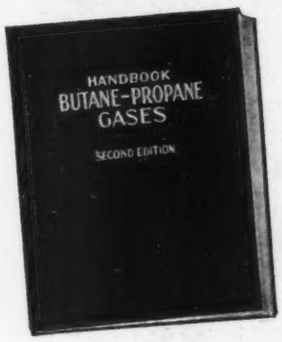

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(Revised September, 1938)

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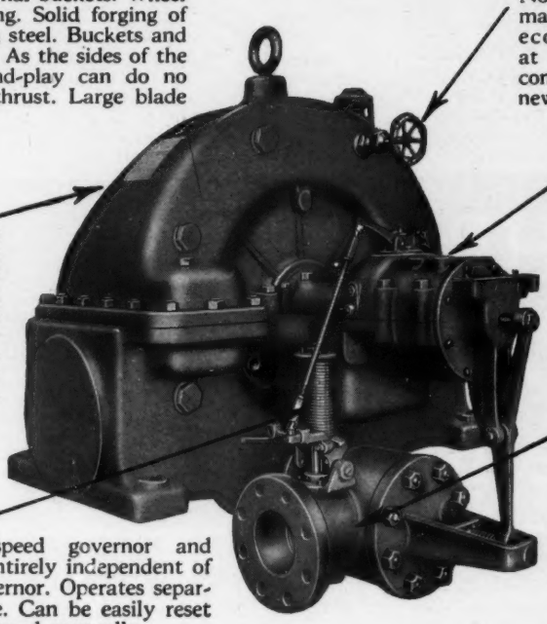

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THE TERRY STEAM TURBINE COMPANY
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Pecos, Texas, operated by the Pecos Refining Company, has sold the plant for junk to El Paso Iron & Steel Company. The plant was erected in 1928 with capacity of 5000 barrels a day.

Cracking: Mid-West Refineries, Inc., Alma, Michigan, has signed license agreement with Universal Oil Products Company, and will erect a two-coil selective Dubbs cracking unit to process 1000 barrels a day and simultaneously to reform about 200 barrels a day of straight-run Michigan gasoline. Frick-Reid Supply Corporation is construction engineer on this job.

Poly: Sunray Oil Company, Allen, Oklahoma, is building a catalytic polymerization plant under license of Universal Oil Products Company, and operations should start this month.

Refinery: Anglo-Iranian Oil Company jointly with Royal Dutch-Shell group is to build a 50,000-barrel refinery at Haifa, Palestine. Plans call for modern combination cracking type of installation, according to report. Contract to The M. W. Kellogg Company.

Enlarge: Tide Water Associated Oil Company and Seaboard Oil Company have let contract to J. W. Pritchard & Company for enlargement of the gas recycling plant operated in the Cayuga field, East Central Texas.

Gasoline: Roeser & Pendleton, Inc., plan erection of a recycling and gasoline extraction plant in the Cayuga field, Anderson County, Texas. The company plans to repressure the Woodbine formation with gas taken from the Trinity sand.

Cracking: Central Refineries at Brandon, Manitoba, Canada, controlled by the Anglo-Canadian Oil Company, is reported planning installation of a cracking unit early in 1939.

Refinery: Gen Schooler, Shawnee, Oklahoma, is reported planning erection of a skimming and cracking plant to process 1000 barrels a day and at reported cost of $50,000, and to crack under license of Universal Oil Products Company.

Refinery: Anglo-Canadian Oil Company, Calgary, Alberta, Canada, states that it is seriously considering erection of a $1,000,000 skimming and cracking plant in the spring of 1939, to process 5000 barrels a day.

Crack: Bay Petroleum Corporation is reported considering the installation of a Dubbs cracking unit and an Ethyl blending plant at its Cheyenne, Wyoming, refinery.

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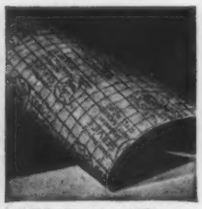

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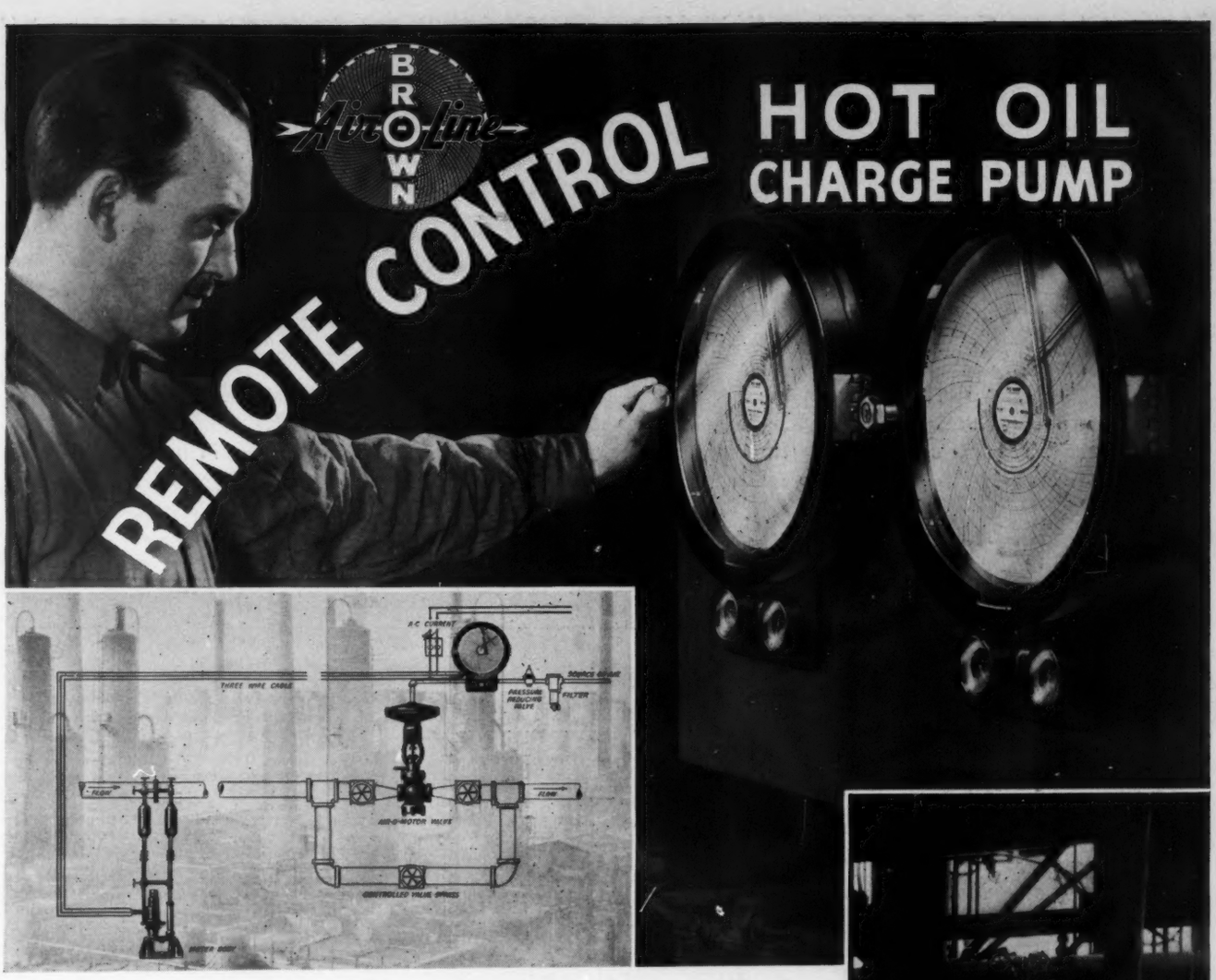
Elaborate Exhibits Planned For Houston Show

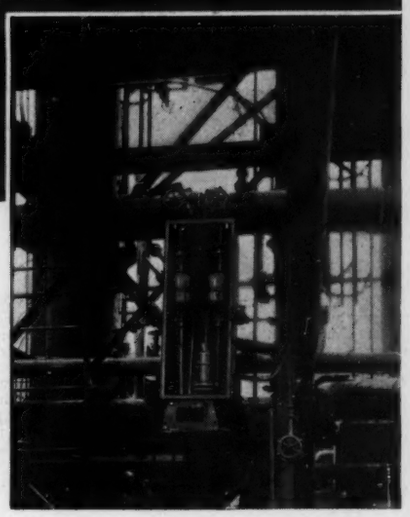
ACCORDING to Ed Lenzner, general manager of the Oil-World Exposition, contracts for space already signed indicate that the 1939 Oil Show in Houston will be considerably larger than the one held in 1937. Approximately the same number of exhibitors that displayed equipment in the previous show have taken space at this early date although the exposition will not be held until April 24 to 29, inclusive. Lenzner stated, moreover, that increased size is not the only factor to make the 1939 show a greater event. Many exhibitors have indicated the extent of their plans for the 1939 exposition; and not only is it evident that the appearance and decorations of the displays are to be much more elaborate but that greater effort is to be put into showing equipment most advantageously for the benefit of visiting oil men.

Increased space has been made available both inside and outside of the exposition buildings and added facilities have been provided by the Coliseum. The additional space and facilities make it possible to take care of more exhibitors and to arrange the exhibits—both inside and out—in one compact area that will enable the visitor to see and inspect all the tools and machinery on display with the least chance of missing a single piece of equipment.

Most of the new exhibiting space will be provided by a large annex which is immediately adjacent to the Coliseum. The greater part of this space is on the same level as the main floor of the Coliseum while additional space has been provided on the ground floor of both the annex and the Coliseum.

Outdoor exhibiting space has been increased approximately 50 percent. Space that lies immediately adjacent to the buildings and which was not available during the 1937 show has now been fixed up and will be used for showing heavy equipment such as derricks, drilling rigs, engines, etc. The outside exhibiting space has been rearranged so that all the outdoor exhibits will be located directly around the exposition buildings. This consolidation of indoor and outdoor exhibits will make the 1939 Oil-World Exposition a highly-concentrated oil show.





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The above photographs show Brown Air-o-Line Flow Controllers mounted at the centralized control board and the meter bodies installed at the remote point of measurement. The schematic diagram shows the principle of electric flow recording by Brown Air-o-Line.

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by

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under the supervision of

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The abstracts here presented are selected from the current literature of science and technology to afford reference to fundamental information not easily available to all readers. Abstracts of articles appearing in readily obtainable trade journals are not included.

Photostat copies of original articles will be supplied at cost by the Leslie Laboratories. Complete or limited bibliographies covering special topics by title, by abstracts, or in complete manuscript, will also be prepared and furnished at reasonable cost by the Laboratories.

Fundamental Physical and Chemical Data

The Heat Capacity at Constant Volume of the System Ethylene Near the Critical Temperature and Pressure, D. B. PALL, J. W. BROUGHTON AND O. MAASS, *Can. J. Res.* **16** (1938) pp. 230-41.

The authors studied the heat capacity of ethylene at constant volume through the critical range beteen 6.5° and 27° C. at an average density slightly greater than the critical density. The heat capacity in the immediate vicinity of the critical temperature is a function of the previous thermal treatment of the system. The temperature control was so accurate that readings could be made to within 0.0003°, and it is believed that accuracy in temperature differences was about 1 part in 1000. The maximum difference in heat capacity depending upon the thermal history was 4.5% in the range 9.36° to 9.50° and 2.6% in the range 9.36° to 10.36°. Measurements of the density of the two phases and of heat capacities near the critical point show that the two phases have similar properties at 10.5°. The results indicate the retention of a large amount of molecular interaction in ethylene above the critical temperature, and are in general agreement with the concept that the liquid state of aggregation can persist above the temperature at which the visible meniscus disappears.

Refraction, Dispersion, and Related Properties of Pure Hydrocarbons, A. L. WARD AND S. S. KURTZ, JR., *Ind. & Eng. Chem., Anal. Ed.* **10** (1938) pp. 559-76.

The paper presents a valuable compilation of data collected by the authors over a period of years, and recently revised and correlated to make the information as useful as possible. The data tabulated are: boiling point, density, refractive index, dispersion, refractivity intercept, and specific dispersion. These are first tabulated in detail for ten classes of hydrocarbons. Following that tables are presented containing average data for specified boiling ranges. Graphs are drawn based on these average properties. Graphs are also presented showing the relationship between density and refractive index for groups of paraffin and olefin isomers. The change in density and refractive index with change in temperature is given, and curves are presented showing the coefficients of cubical expansion as a function of boiling point, and the change in density per degree as a function of density. Ten series of hydrocarbons are considered: four are straight-chain or noncyclic hydrocarbons, the paraffins, monoolefins, nonconjugated diolefins, and conjugated diolefins. Four monocyclic series are considered: the naphthenes, the monoolefins, the conjugated diolefins, and the aromatics. Two polycyclic series are considered: the saturated dicyclic, and the saturated tricyclic. A bibliography of 177 references is included.

The Compressibilities of Hydrogen and of Four Mixtures of Hydrogen and Nitrogen at 0, 25, 50, 100, 200 and 300° and to 1000 Atmospheres, R. WIEBE AND V. L. GADDY, *Jour. Amer. Chem. Soc.* **60** (1938) pp. 2300-3.

The work is a continuation of that of the Bureau of Chemistry and Soils on the compressibilities of hydrogen, nitrogen, and mixtures of these gases. Work by others since 1930 is reviewed and summarized. A modified Bartlett compressibility apparatus is described. The compressibilities of hydrogen and four hydrogen-nitrogen mixtures were measured at 0, 25, 50, 100, 200 and 300° C. and over the pressure range to 1000 atmospheres.

Chemical Compositions and Reactions

Synthesis of High-Molecular Paraffins, H. PICHLER, *Brennst.-Chem.* **19** (1938) pp. 226-30.

Data are presented on tests made to develop a method of synthesis of the very high-melting paraffins. To obtain the higher hydrocarbons from carbon monoxide and hydrogen at high temperatures and pressures, ruthenium is the best of all catalysts, and the most favorable reaction conditions were found to be 100 atmospheres pressure and a temperature just below 200° C. A long-duration run was made under these conditions for a period of 26 weeks. The resultant solid synthetic product was of white appearance and had a melting point of 118-119° C. Hitherto unknown paraffins of very high melting point were isolated and examined. Molecular weights were in the range from 2100 to 800 corresponding to saturated paraffins of the formula $C_{200}H_{402}$ to $C_{800}H_{1202}$. The melting points ranged from 123.5° to 131.5° C.

The Ethane Equilibrium, R. N. PEASE AND A. M. BYERS, *Jour. Amer. Chem. Soc.* **60** (1938) pp. 2489-91.

Additional experiments on the ethane-ethylene hydrogen equilibrium have been made to determine whether the presence of volatile hydrocarbons higher than ethylene and ethane could have invalidated previous analytical work, as has been suggested by Kassel and Storch. From the new evidence secured it is certain that the error is less than 10%. A comparison of equilibrium constants calculated from the experimental work with those calculated on the basis of the Nernst Heat Theorem and the Third Law emphasizes the excellent agreement. It is concluded that there is no ground for ignoring experimental data on the ethane equilibrium dealing with the question of free rotation in the ethane molecule.

The Polymerization of Ethylene with Compounds of Aluminum as Catalyst, F. C. HALL AND A. W. NASH, *Jour. Inst. Pet. Tech.* **24** (1938) pp. 471-95.

The catalytic polymerization reactions of ethylene are reviewed with particular reference to that induced by aluminum chloride. The effect of metallic aluminum on this reaction has been investigated at various temperatures. The products of reaction include organo-metallic ethyl derivatives of aluminum and polymerized hydrocarbon oils of high boiling point. The residual and distillate lubricating-oil fractions therefrom have relatively high viscosity indices in contrast to those from the polymerization of ethylene with aluminum chloride alone. The optimum values were obtained for oils from the reaction at 200° C. The cracking action of aluminum chloride on hydrocarbon oils can be completely inhibited by the presence of metallic aluminum or magnesium; zinc has a less pronounced effect. At temperatures above 200° C. the polymerization reaction is further complicated by the catalytic activity of the aluminum ethyl derivatives. Under suitable conditions high yields of butene-1, hexenes and octenes can be obtained by the direct polymerization of ethylene, using either aluminum diethyl chloride or the simple aluminum chloride-aluminum catalyst. The reaction is in accordance with the mechanism proposed by Taylor and Jones for the polymerization of ethylene by free alkyl radicals. It is suggested that these radicals are derived from the incipient thermal decomposition of the aluminum ethyl compounds. A bibliography of 38 references is included.

The Polymerization of Isobutene, E. W. R. STEACIE AND G. SHANE, *Can. J. Res.* **16** (1938) pp. 210-12.

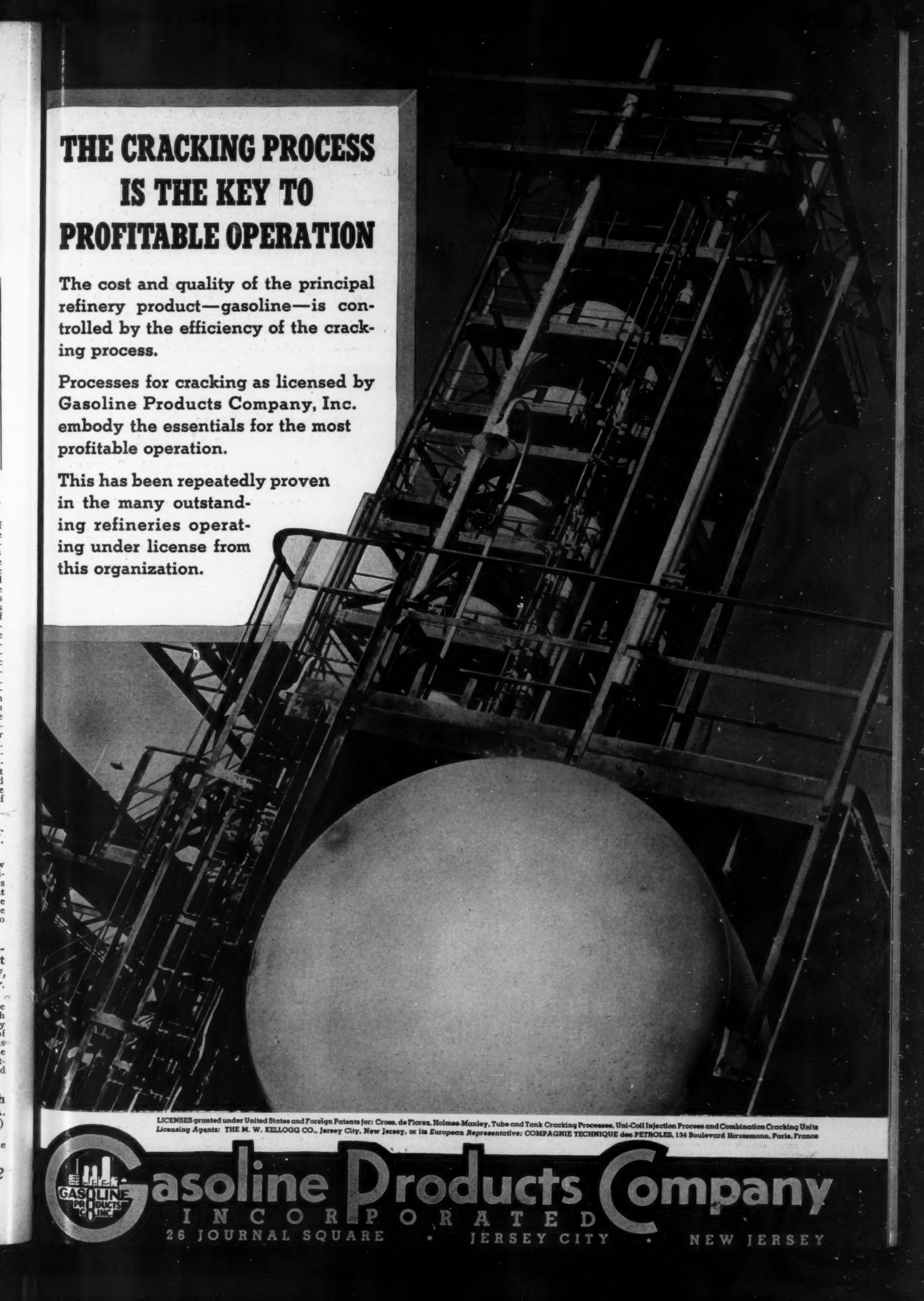
Isobutene polymerization was studied at low temperatures and pressures, and under conditions such that small percentage conversions were had. The reaction rate curves indicate that the reaction proceeds autocatalytically. The process appears to be too complex to permit the making of definite statements with respect to the kinetics of the reaction.

Reaction of Isobutene and Diisobutene with Phenol, with and without Scission of C-C Linkages, V. N. IPATIEFF, H. PINES AND B. S. FRIEDMAN, *Jour. Amer. Chem. Soc.* **60** (1938) pp. 2495-7.

4-t-Butylphenol and 2,4-di-t-butylphenol have been obtained in the alkylation of phenol with diisobutene at higher temperatures either by use of phosphoric acid as catalyst or by use of a large excess of sulfuric acid. Phenol was readily alkylated by isobutene in the presence of phosphoric acid at 100° C. to produce p-t-butylphenol and 2,4-di-t-butylphenol in 40% and 30% yields, respectively.

The Reaction of Oxygen Atoms with Methane, E. W. R. STEACIE AND N. A. D. PARLEE, *Can. J. Research* **16** (1938) pp. 203-9.

The reaction of oxygen atoms with methane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was investigated in the temperature range 30° C. to 330° C. The oxygen atoms were produced by the discharge-tube method. The products were found to be carbon monoxide, carbon dioxide, and water. Methane was not found among the reaction products. The activation energy is approximately 8 kg.-cal. Either the reaction postulated by Norrish, $O + CH_4 = CH_2 + H_2O$, does not take place to any extent, or the reaction $CH_2 + CH_4 = C_2H_6$ has an activation energy greater than 11 to 12 kg.-cal.

The Addition of Sulfur, Hydrogen Sulfide and Mercaptans to Unsaturated Hydrocarbons, S. O. JONES AND E. E. REID, *Jour. Amer. Chem. Soc.* **60** (1938) pp. 2452-5.

Sulfur acts with hydrogen in unsaturated hydrocarbons to form hydrogen sulfide, a part of which adds to the double bond forming a mercaptan which then adds to more of the unsaturated hydrocarbon to form a sulfide. The addition of hydrogen sulfide to unsaturated hydrocarbons takes place readily and follows Markownikow's rule. Sulfur is an effective catalyst. Mercaptans add to double bonds in accordance with Markownikow's rule if peroxides are absent and sulfur is used as a catalyst. In the presence of peroxides the the abnormal addition takes place, and the amount of peroxide required is small.

Preparation and Properties of 2- and 3-Chloropentanes, F. C. WHITMORE AND F. A. KARNATZ, *Jour. Amer. Chem. Soc.* **60** (1938) pp. 2536-9.

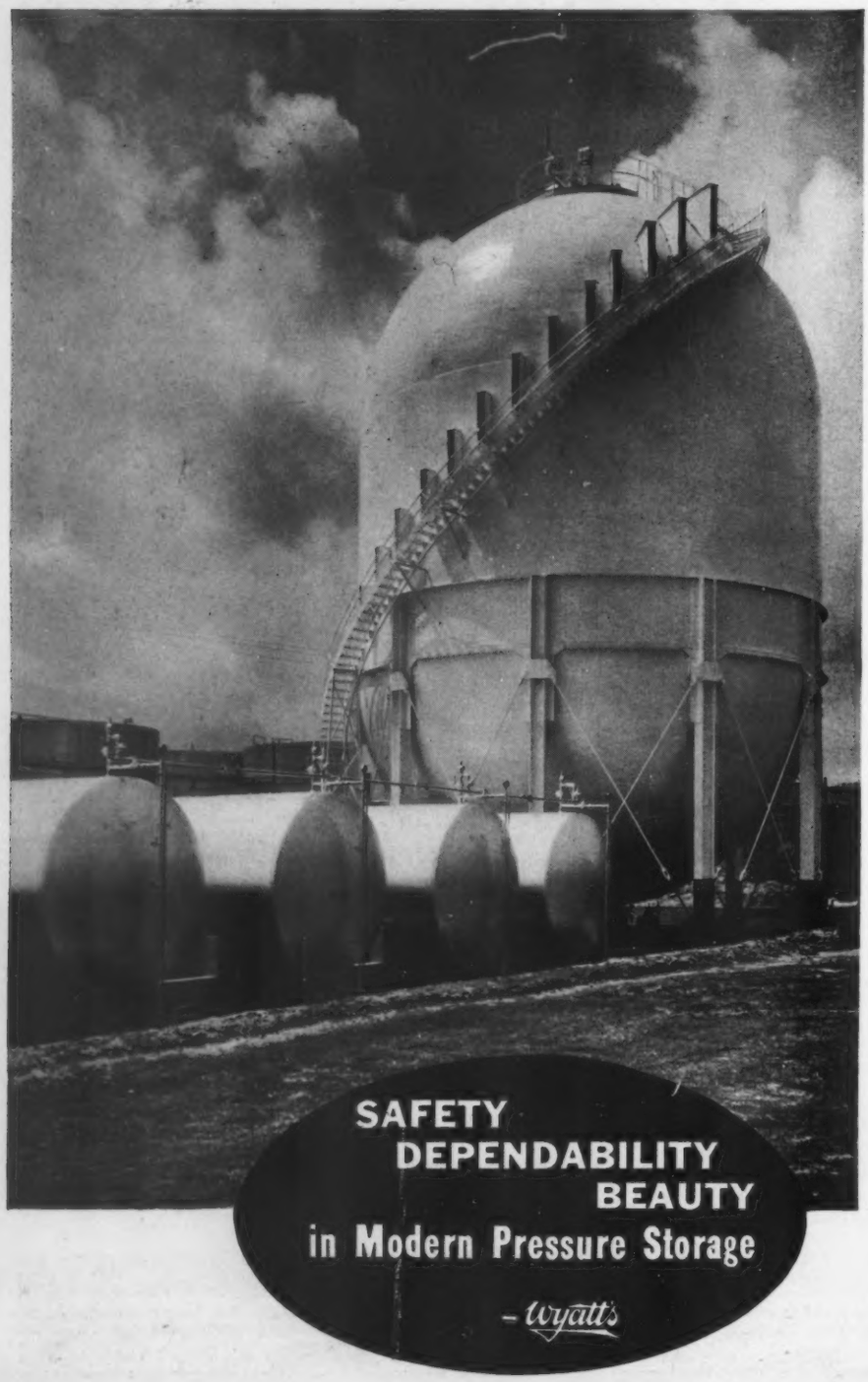
2- and 3-Chloropentanes were made by the action of thionyl chloride and pyridine on the corresponding alcohols. Physical properties of the chlorides were determined. The chlorides were found to be stable to heat, but that they were isomerized to an equilibrium mixture by shaking with zinc chloride-HCl solution at room temperature. Mixtures of the chlorides were obtained in all instances of the treatment of the carbinols with hydrogen chloride.

Isomerization during the Preparation of n-Amyl Chloride, F. C. WHITMORE, F. A. KARNATZ AND A. H. POPKIN, *Jour. Amer. Chem. Soc.* **60** (1938) pp. 2540-2.

The action of zinc chloride and hydrochloric acid on n-amyl alcohol produces n-amyl chloride in 57% yield and 10% of a mixture of 2- and 3-chloropentanes. The action of zinc chloride and hydrochloric acid on n-amyl chloride yields 3% of a mixture of 2- and 3-chloropentanes. The action of thionyl chloride on n-amyl alcohol in pyridine gives n-amyl chloride in 80% yield with no rearranged products. A corrected refractive index for n-amyl chloride, free of traces of 2- and 3-chloropentanes, is recorded.

Fluorinated Derivatives of Propane. II, A. L. HENNE AND E. C. LADD, *Jour. Amer. Chem. Soc.* **60** (1938) pp. 2491-5.

The synthesis of C_3Cl_8, $CHCl_2CCl_2CCl_3$ and $CCl_3CHClCCl_3$ have been improved. From these compounds, the mono-, di- and trifluorides have been obtained by replacement of chlorine atoms by fluorine. The formulas of the new derivatives have been established experimentally for the mono- and difluorides, and reasoned out for the trifluorides. The properties of the compounds have been tabulated, together with those of three additional fluorochloropropanes that were synthesized independently for identification purposes.



Manufacture: Processes and Plant

Separation Processes, M. RANDALL AND B. LONGTIN, *Ind. & Eng. Chem.* **30** (1938) pp. 1188-92.

In a previous paper by the same authors the general methods of analysis of separation processes were outlined and discussed. The equipment used in separation processes can be considered as composed of simple units that may be combined in a number of ways. The molal property vs. mole fraction diagrams for a number of such simple unit parts are presented, and the combination of these unit parts into the design diagram for a complete unit is illustrated. Special consideration is given to column sections with inefficient plates and column sections operating with entrainment. Solvent extraction processes can be considered and analyzed in a manner similar to that applied to distillation processes. The authors consider that general graphical analyses can be set up for any counter-current process. In case of distillation this is done by the use of molal heat content, mole fraction, diagrams. Analogous diagrams are indicated for other processes. Under certain simple conditions the design method reduces to various standard methods. A set of unit graphical constructions has been developed for use in further work, and the way in which they can be used in design problems is illustrated.

Application of Vaporization Equilibrium Constants to Production Engineering Problems, D. L. KATZ, *Trans. Am. Inst. Mining Met. Engrs.* **127** (1938) pp. 159-77.

Equilibrium data for the volatile components in systems composed of crude oil and natural gas are reviewed, and the physical properties of the hydrocarbons discussed. Computation of the results of equilibrium vaporization of solutions of crude oil and natural gas are considered, and illustrated with examples of the many uses of this type of information in petroleum engineering.

Rate of Evaporation from a Free Water Surface by a Perpendicular Air Stream, M. C. MOLSTAD, P. FAREVAAG, AND J. A. FARRELL, *Ind. & Eng. Chem.* **30** (1938) pp. 1131-8.

Circular water surfaces ranging in area from 0.05 to 0.37 square feet were subjected to the action of a perpendicular air stream and velocities ranging from 3 to 15 feet per second, which velocities correspond to mass velocities, G, of approximately 800-4000 pounds/(square foot) (hour). Tests at prevailing room temperature and humidity and at the lower velocities gave rates of evaporation about 50 percent greater than that usually found for the evaporation of water to an air stream flowing parallel to the surface. At the higher velocities the coefficients were about 10 percent above those obtained with parallel flow as compared with the data of Lurie and Michailoff, but 30 percent below the rates determined by Shepherd, Hadlock, and Brewer. The heat transfer coefficient is given by the equation $h_c = 0.37\ G^{0.37}$. Tests made with air streams at 125°, 175° and 225° F. gave the same evaporation coefficients as the tests at room temperature. Coefficients found in still air

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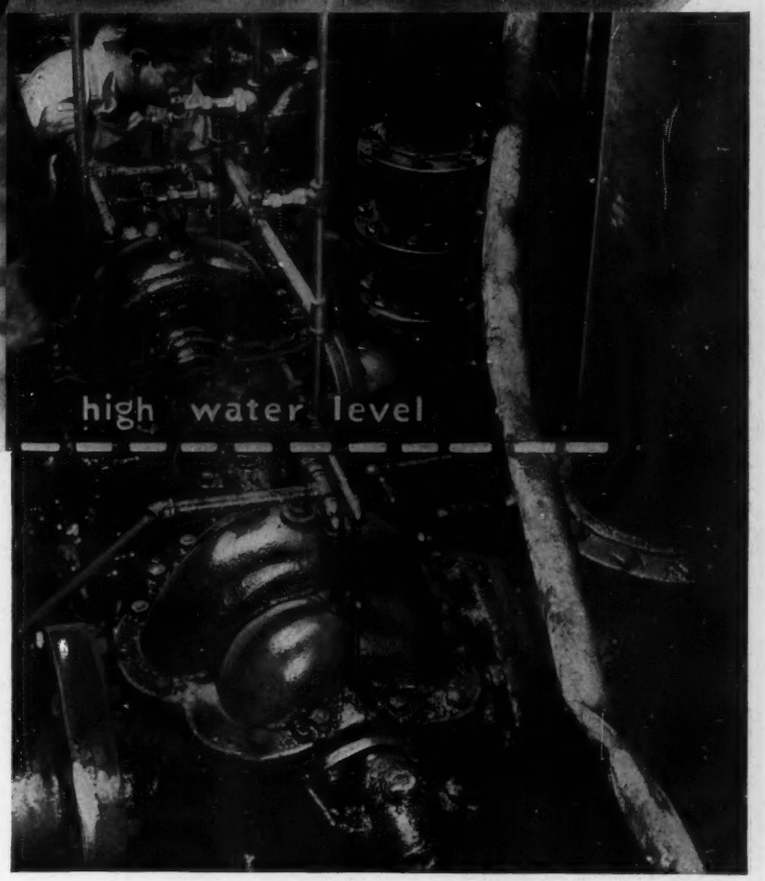

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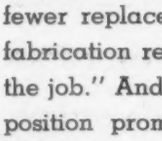

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were only about 2 percent of those found at the lowest air velocity.

Catalytic Processes in Applied Chemistry, T. P. HILDITCH AND C. C. HALL, Pp. XXII + 478. Second Edition. Chapman & Hall, Ltd., Henrietta St. W. C. 2, 25s.

The first edition of this valuable monograph appeared in 1929. In the present second edition material has been added discussing the processes concerned with the making of liquid fuels from coal, tar, petroleum and water-gas, as well as the catalytic formation of polymer gasoline and of lubricating oils. Among the subjects considered are the general theoretical aspects of catalysis at solid surfaces, in homogeneous systems and in the presence of enzymes, surface catalysis, production of hydrogen, the water-gas reactions, hydrogenation-cracking of tars, coal and oil, the synthesis of ammonia, nitric acid and sulphuric acid, the hardening of fats, fermentation processes, homogeneous catalysis in liquid systems, and the catalytic polymerization of organic compounds, rubber, polymer resins and the polymer products of petroleum hydrocarbons.

Refining of Shale Oil in Scotland, G. H. SMITH AND W. B. PEUTHERER, *Jour. Inst. Pet. Tech.* **24** (1938) pp. 513-36.

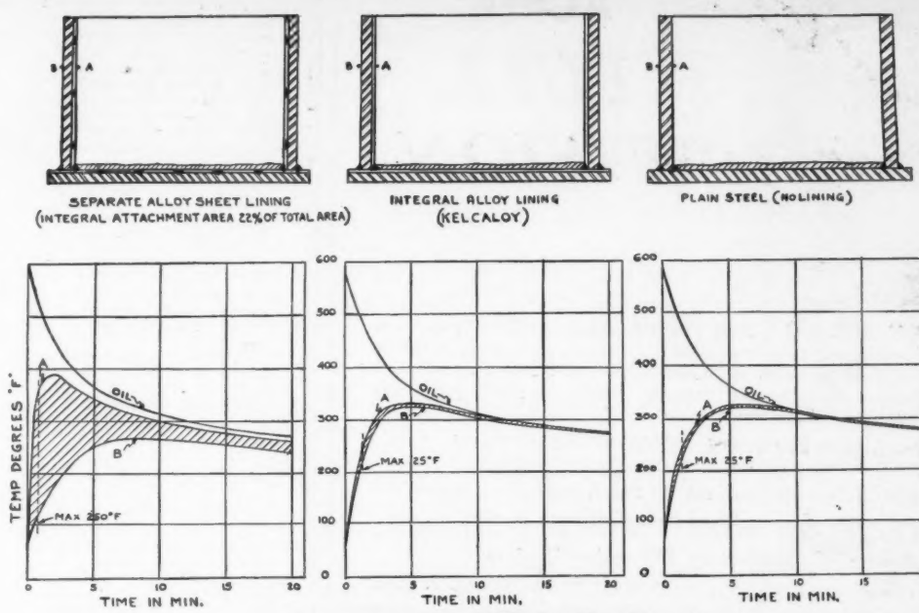
The refining of shale oil in Scotland has been directed at different periods to the production of various primary products. In the early days of the industry burning oil was the main product, but as the industry developed the refining of shale oil aimed at the production of a full range of products, including motor spirit, solvent naphtha, burning oil, gas oil, wax, light lubricating oil and fuel oil. The processes involved have in the main been adequately described in previous publications. The present paper deals with what are today the most important products, namely, diesel oil for high-speed compression-ignition engines, motor spirit and wax. The chemistry of shale oil, particularly Scottish shale oil, is briefly reviewed. Unfortunately only the lightest fractions have been studied in any detail. The refining steps involved in producing the maximum quantity of diesel oil are indicated, together with the experimental work on which the refining scheme at present used is based. The extraction of wax and the refining of this product is considered in some detail, including separation, treatment, sweating, decolorizing, and the properties of finished waxes. Methods for the manufacture of motor spirit from shale oil with special reference to the effect of them on octane rating, are discussed.

Motor Fuel Economy of Europe, G. EGLOFF, *Ind. & Eng. Chem.* **30** (1938) pp. 1091-1104.

Self-sufficiency is the keynote in the motor fuel economy of the European nations. Coal is converted into motor fuel by carbonization, hydrogenation, and the use of the water gas reaction. Alcohols from farm products and methanol from hydrogenation of carbon monoxide and from wood distillation are also used. Methane, ethane, propane, and butanes, or city gas, are used in compressed form in steel cylinders at 3000 to 4000 pounds per square inch pressure. There are 26,000 motor vehicles of this type in use. Some vehicles generate their own gas from wood or charcoal, and there are about 9000 such wood-burning motor vehicles in Europe. The article includes statistics of different fuels, general flow sheets of processes, and a number of interesting photographs showing production facilities and methods of utilization of the different fuels.

Bulk Production of Hydrogen, D. BROWNLIE, *Ind. & Eng. Chem.* **30** (1938) pp. 1139-46.

Various possible ways of making hydrogen are given. Because of the large developments in hydrogenation, synthetic nitrogen, synthetic liquid fuel, soap, edible fat, synthetic methanol, and solvents, hydrogen has become, in recent years, one of the world's most important raw products. Three methods are used to produce almost the entire world's commercial production of hydrogen. (a) The total gasification of coal, coke, or lignite by the water-gas and producer gas processes. This method at present accounts for about 55 percent of the total hydrogen production. (b) The separation of hydrogen from coke-oven gas by low temperature compression liquefaction. This method accounts for about 26 percent of the total. The electrolysis of water accounts for about 16 percent. All other methods produce but 3 percent of the total hydrogen. The production of hydrogen from water-gas in various variations of the process are described. Methods of making hydrogen from coke-oven gas, including liquefaction, and also chemical methods, are briefly reviewed. Finally, the manufacture of hydrogen from pe-



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troleum gases or natural gas, and through electrolysis, are described.

Relation of Soil Properties to Corrosion of Buried Steel, W. F. ROGERS, *Ind. & Eng. Chem.* **30** (1938) pp. 1181-88.

The subject of the corrosion of buried steel pipe is of great importance to the oil, gas, and water industries. From laboratory and field studies the author concludes that the controlling factor in soil corrosion of buried steel pipes is the effect of variation in the soil-water-air proportion. The electrical resistivity of the soil exerts an influence on its corrosion rate. The pH value of the soil exerts an influence on its corrosion rate. A comparison of soil resistivity measurements at saturation with the corresponding pipe pit depth show that there is a definite trend between resistivity and corrosion. The trend is not sufficiently accurate, however, to be used as an index of soil corrosion. Comparison of soil pH values with field corrosion rates indicate a complete lack of any correlation between these quantities. The corrosion rate of a soil in the field may be determined by following its seasonal variation in water-air volumes and checking against a laboratory index test.

Centrifugal Pumps for the Process Industries, H. E. LABOUR, *Ind. & Eng. Chem.* **30** (1938) pp. 1105-9.

Centrifugal pumps are compared to positive displacement pumps. The general characteristics of centrifugal pumps are briefly reviewed, including the self-priming centrifugal pump. The self-priming pump combines the advantages of the centrifugal pump with the suction ability of the positive displacement pump. The turbine pump is briefly described. Its construction has an effect similar to multi-staging a standard centrifugal pump insofar as the building of pressure is concerned. However, the turbine pump is dependent upon close clearances, and is primarily of value in the smaller sizes where high head and small capacities are desired. Two factors have contributed to the use of centrifugal pumps in the processing industries. First was the introduction of the self-priming centrifugal pump in 1922; second was the development of corrosion-resistant alloys beginning about 1923 with general interest in the use of high-chromium steels and the chromium-nickel alloys. The materials of construction of pumps for the handling of different acids and alkaline solutions are considered. Service applications of centrifugal pumps are discussed, including circulating systems, pumping out from vacuum, and pressure filter feed.

A Hazardous Nuisance: Static Electricity, E. E. TURKINGTON, *Natl. Safety News,* Nov. (1937) p. 38; *Ind. Safety Survey (Intern.)* **14**, p. 94.

The elimination of static electricity hazards by means of humidification and ionization of the atmosphere and the grounding of objects is discussed. Precautions must be taken to prevent workmen themselves from becoming statically charged. The author notes that special precautions are required for petroleum products.

Discharge Rates from Gas Flowmeters, J. C. WHITWELL, *Ind. & Eng. Chem.* **30** (1938) pp. 1157-62.

A new method is proposed for the plotting of discharge flow rates, for instruments of the Venturi and orifice types, against the differential manometer reading. The groups to be plotted are so calculated that one line on such a plot will be universal for varying values of inlet pressure and temperature. The groups are derived by rearrangement of the terms of well-known equations. Long-tube capillary orifices were also studied, both in the viscous and turbulent flow ranges for the gas in the capillary. Alignment charts are given that provide a convenient method of calculating the groups found to be necessary in the new type of plot.

Products: Properties and Utilization

Studying Engine Combustion by Physical Methods, L. WITHROW AND G. M. RASSWEILER, *J. Applied Physics* **9** (1938) p. 362.

By fitting a glass observation window to the top of the cylinder it has been possible, through use of a high-speed cinematograph camera, to photograph the flame during a single cycle. Exposures of 1/6000 seconds are possible. The authors show a typical set of photographs, by which it is demonstrated that the flame travels across the combustion space, a distance of 5 inches in 43° of crank angle, or in 1/125 seconds. As engine speed increases the rate of flame-propagation likewise increases. By mounting a spectrograph above the window, emission

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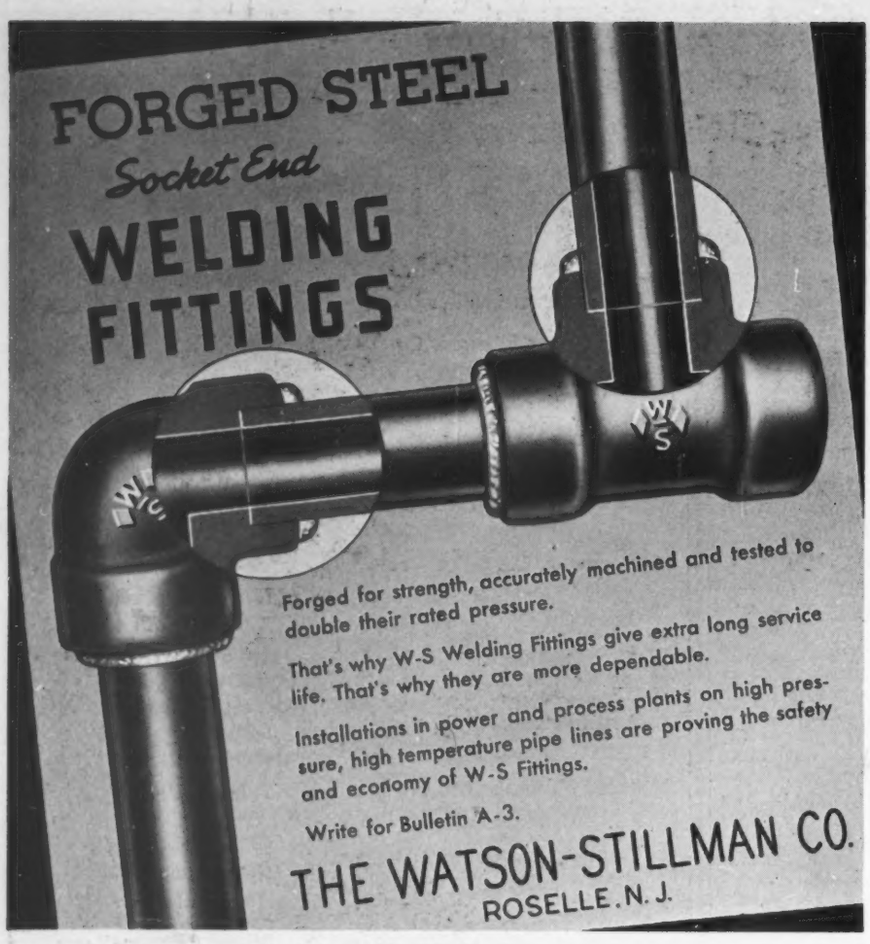
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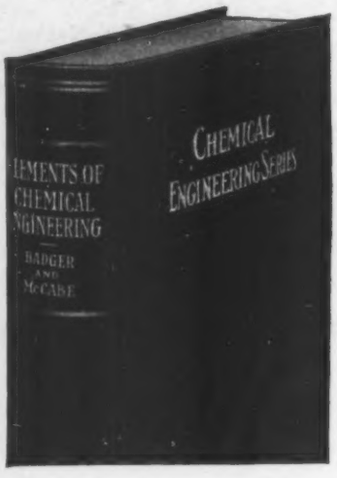

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spectra of various parts of the flame were obtained. Temperatures were determined by means of the sodium line reversal method. Comparisons made between non-knocking and knocking explosions showed the occurrence of spontaneous combustion ahead of the normal flame-front, and also the more rapid flame travel in the knocking type of explosion. Pressure waves can be demonstrated in this type of combustion by time-displacement photographs of the flames, and these can be correlated with the pressure as measured by pressure indicator. It is believed that a pressure variation of 108 pounds per square inch occurs in these waves. The information secured leads to the theory that the loss of power due to knocking is caused by the increased turbulence which results in a larger heat loss to the walls of the cylinder.

Fundamental Technology of Petroleum Solvents, E. M. TOBY, JR., *Official Digest Federation Paint & Varnish Prod. Clubs* (1938) pp. 261-74.

The properties of various petroleum solvents that are manufactured today are reviewed, with reference to solvent power, corrosion, flash point and volatility. The methods that are used for the determination of solvent power are described and considered in some detail. The Kauri-butanol method is not regarded as satisfactory. Reference is made to the fact that special products with desired properties will be produced to order.

The Nature and Behavior of Refrigerating Oils, S. J. M. AULD, *Ice and Cold Storage* **41** (1938) pp. 46-7.

Oils for use in refrigerating machines of all types should be straight mineral oil of high chemical stability, low pour point, small change of viscosity with temperature, and should be free from water. Water in oils used with SO_2 machines forms sulfuric acid, which is corrosive and forms tarry substances in the oil. In ammonia machines, emulsification of the oil occurs if the oil contains moisture. This is particularly true when the oil has been in use for some time and has a high neutralization value. In such cases ammonia soaps are formed by reaction of the ammonia with naphthenic acids.

Notes on the Lubrication of Refrigerating Plants, W. R. SINCLAIR, *Ice and Cold Storage* **41** (1938) pp. 45-6.

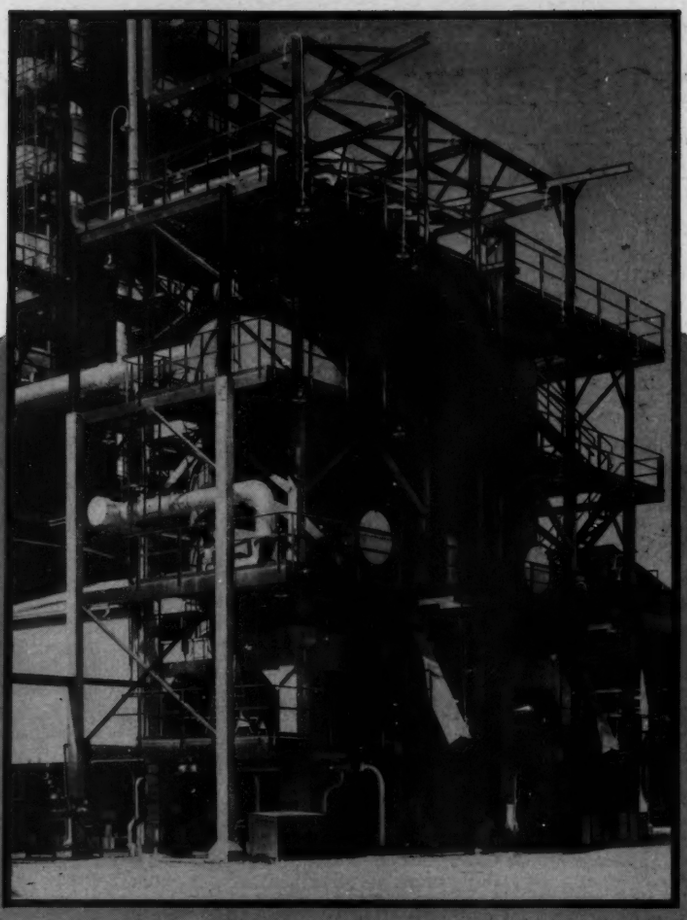
It is necessary carefully to consider the behavior and physical properties of oils as affected by temperature varying between —60° F. and +360° F. when the oils are associated with gaseous and liquid refrigerants in varying proportions. The relative specific gravities of oils and refrigerants are important, as well as their miscibility and solubility under the various temperatures and pressures obtaining. The action of air and moisture that enters at times is important. The possibility of the formation of explosive, combustible or toxic compounds must be considered.

The Properties of Asphaltic Bitumen in Relation to the Road, F. H. GARNER, *Jour. Inst. Pet. Tech.* **24** (1938) pp. 496-512.

The author presents an instructive review of the properties of asphaltic bitumen in relation to utilization. To abstract the article is difficult because the subject matter is in itself a review. Among the subjects discussed are: the components of asphaltic bitumen—asphaltenes, asphaltic resins and petrolenes, including a tabulation showing the properties of typical asphalts and their content of these components, the chemical composition of the asphaltenes, asphaltic resins and petrolenes, sulphur compounds in asphaltic bitumens, the oxygen and nitrogen compounds in asphalts, physical properties, including consistency, flow properties in relation to composition, flow properties in relation to temperature, flow properties in relation to structure, viscosity, penetration and softening point, ductility, elasticity, and color, chemical properties including the changes produced by light and oxidation, and finally, adhesiveness. Although admitting that our present knowledge of asphalts suffers from the lack of a number of connecting links, the author stresses the selection of these products should be based principally on flow properties and resistance to change in properties.

Determination of Carbon and Hydrogen, S. NATELSON, S. S. BRODIE, AND E. B. CONNER, *Ind. & Eng. Chem., Anal. Ed.* **10** (1938) pp. 609-12.

The authors recently described a portable and easily constructed apparatus for the determination of carbon and hydrogen designed to analyze a 70 mg. sample. This apparatus has now been successfully scaled down for application to micro samples of 2.5 to 35 mg. weight. The apparatus and the technique of using it are described and illustrated in several diagrams. Representative results are presented.



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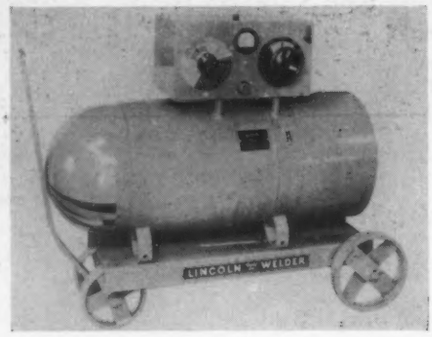
These welders have both job selector and current control calibrated and equipped with dials which indicate the type of work and the number of amperes for each and every setting. It is claimed that this development enables the welding operator to secure highest quality welds and highest possible welding speeds because he can vary both the slope of the volt-ampere curve and the amount of welding current independently and positively to suit every job encountered.

Another feature of this welder control is that both voltage control (job selector) and current control are continuous in operation.

Other features of this new line of Lincoln Welders include:

A self-protected motor on all AC motor-driven welders which is said to permit sustained operation with large sized electrodes at high average welding currents without danger of burnout.

Separate excitation of the welding generator in all types of these new welders provides the generator with a constant sorce of excitation which is independent of conditions at the welding arc. It is claimed that this aids in the maintenance of a steady arc for minimum spatter.



Lincoln "Shield-Arc" Welder, AC Motor-Driven Type.

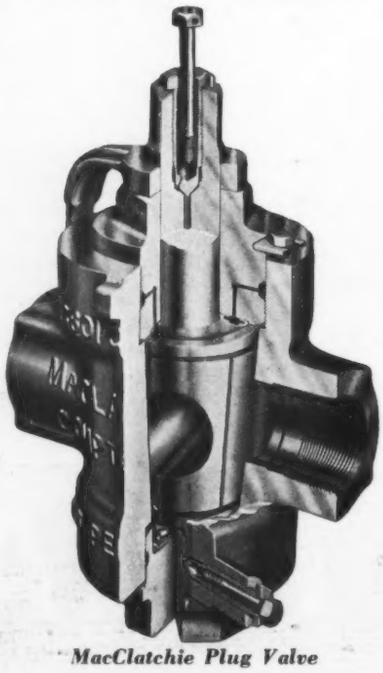
A laminated magnetic circuit is employed in all types of welders providing minimum reluctance to the flow of magnetic flux. It is claimed that this construction quickens the response of the welding generator to changing arc conditions, resulting in greater arc stability and wider welding range.

This new line of Lincoln welders is available in AC and DC motor-driven types, belted or coupled type, and in gasoline engine- and Diesel engine-driven types, in all standard ratings.

Plug Valve

MacCLATCHIE MANUFACTURING COMPANY

MacClatchie Manufacturing Company, Compton, California, has announced a new development in plug valve construction known as the "Hydro-Seal" plug valve, which the manufacturer states incorporates engineering advancements to eliminate packing troubles and make the valve leakproof under all types of installations. The new model valve is entirely grease packed. It has no metal, rubber, fabric or leather packing of any type. Instead, two separate lubrication chambers, each equipped with the new "Lubricheck" permit positive thorough packing at all points where fluid might escape. All the packing in the new valve can be tightened or completely renewed from the outside while the valve is working under high pressure.



MacClatchie Plug Valve

Another feature is the arrangement of the thrust bearings, the maker states. By improved design the fluid pressure has been distributed so that it tends to push the plug down instead of up. Thus thrust load is carried on a roller bearing assembly, adjusted to exactly balance the thrust pressure. Thus the higher the pressure the tighter the seal, but the plug will neither freeze nor turn hard under high pressure because it rotates upon the specially designed thrust bearing. The "Lubricheck" feature enables the grease chamber to be completely closed off while a new grease stick is inserted, thus permitting repacking of the valve under high pressures while in service.

Alloy Metal

COLONIAL ALLOYS COMPANY

Colonial Alloys Company, Philadelphia, announces development of Colalloy, a non-ferrous silvery metal, two thirds lighter than steel and most common metals, which is said to be unusually resistant to corrosion, with good electrical and thermal conductivity, strong, workable, and low in cost.

This metal is made in all forms, shapes and gauges, and range of sizes that are available in most common metals. Dies and tools are on hand to make commonly used items such as pans, trays, condenser tubes, containers, etc. It is recommended for use where light weight, strength, corrosion resistance, non-toxicity, electrical and thermal conductivity and non-sparking qualities are required. The makers state that for its physical properties, Colalloy has a range of hardness, tensile strengths, working factors and other properties which make it an all-purpose metal. It lends itself to common fabrication practices with standard tools and equipment. Free laboratory testing samples can be secured on request and technical information and specific data for individual uses will be furnished.

Pipe Threaders

THE RIDGE TOOL COMPANY

The Ridge Tool Company, Elyria, Ohio, introduces the new RIDGID No. 65R and 85R series of pipe threaders made now of rugged all-steel and malleable alloy construction, with drop-forged hardened tool steel cam plates—said by the manufacturer to give quicker, easier pipe threading. The No. 65R and 85R series thread 4 sizes of pipe, 1-, 1¼-, 1½- and 2-inch, all with one set of chaser dies. Only 4 dies—instead of the usual 16, made of semi high-speed tool steel, stay in the threader, saving time and trouble for the operator.

The new No. 65R and 85R series pipe threaders offer a choice of two mistake-

COOL HEADS for HEAT TRANSFER

Representatives from coast-to-coast keep Scovill informed of heat transfer conditions, problems, and solutions. Working with you in the field, as they do, their approach to any condenser tube situation is cool and practical, as well as theoretical. Frequently they can base a method of approach on Scovill's Heat Exchanger Tube Manual, a book that contains, as far as we know, a larger amount of tube data than any other ever published. Largely, it was built on the experiences Scovill men had while working with you.

And if your company is a Scovill customer, you may expect regular visits from a Scovill man. That is a part of this company's service . . . a maintenance of Scovill interest after the job is done.

Thus, Scovill provides you with two services. First of these is Engineering data. Second is Engineering on-the-spot, at your command. But there is a third service on which the first two are founded. And this is the kind of scrupulous Engineering we put into production.

We wish we could tell you in this space of the exactness of control that goes into extrusion, hot piercing, and cup-drawing processes of producing Scovill tubes. But we suggest you send for a Scovill Condenser Tube Booklet that will give you a clear picture of this, as well as other important information. Ask for *Scovill Condenser Tubes,* addressing Scovill Manufacturing Company, 15 Mill Street, Waterbury, Connecticut.

A refinery forced to use polluted circulating water in coolers and condensers operating at relatively high temperatures was dissatisfied with the service life of Admiralty tubes: Scovill engineers made a study of conditions — recommended a different, but standard, alloy which increased tube life several times. The increase more than offset higher first cost of the recommended alloy; "off the line time" and retubing costs have been minimized.

SCOVILL
Masters of Metal

Scovill Condenser Tubes

one product . . . three services

proof, practically automatic workholders, a cam type and a plate type. There are no bushings—both types simply set to pipe size and are tightened with one screw. These workholders take 2-inch couplings for threading 2-inch close nipples. Closed chaser slots on the die face will not stretch.

This manufacturer also has announced a new RIDGID series of poster pipe threaders with all-steel and malleable-alloy construction. Four sets of chasers thread 1 to 2-inch pipe. Full-floating posts are separately replaceable. These threaders also give a choice of cam or plate type workholders, both practically automatic. Chaser dies fit any make of poster threader and all dies of the same number are identical and are interchangeable with any similar number of any other RIDGID Poster set.

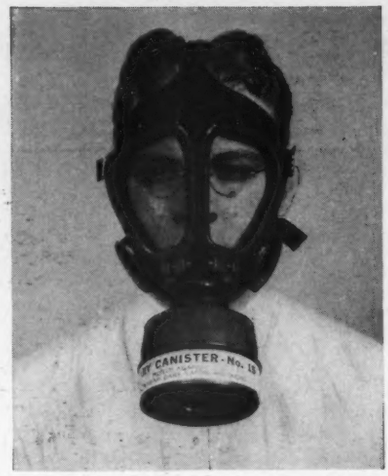
Gas Mask

ACME PROTECTION EQUIPMENT COMPANY

Acme Protection Equipment Company, 3611 Liberty Avenue, Pittsburgh, Pennsylvania, announces a new No. 5 full vision snout type canister gas mask which embodies a number of improvements in gas mask construction.

Outstanding features of the No. 5 mask include full vision lenses, which enable the wearer to see equally as well as when not wearing a mask, and a light weight canister, directly connected to face piece, permitting the wearer to move about with freedom.

The No. 5 mask is recommended for use in low gas concentrations or for short periods in higher concentrations.



Acme No. 5 Full Vision Gas Mask

Canisters are available for protection against practically all poisonous gas, including organic vapors and acid gases, ammonia, hydrocyanic acid, chlorpicrin, etc.

Special Tap

LANDIS MACHINE COMPANY

Landis Machine Company, Waynesboro, Pennsylvania, has recently designed a special 5-inch tap with replaceable chasers. This tap is intended to be used in conjunction with special die heads for producing the screw mechanism which will operate the control gates of a large dam.

This special tap will be used for finishing and sizing after the threads have been "roughed out" on a lathe. The thread is of the Acme form, 5 inches diameter, 2/3-inch pitch, 1-1/3 lead, with a depth of .346 inch.

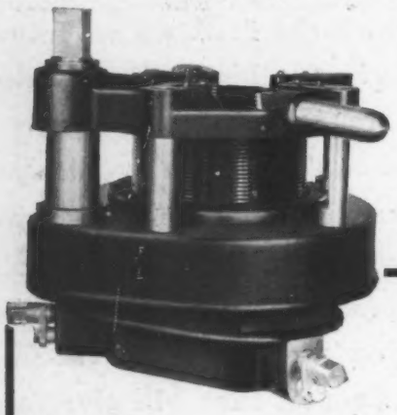
The tap body, which is 30 inches overall in length, is made of alloy steel and has been precision ground after heat treating to insure accuracy. The chasers are securely locked in the correct cutting position by means of three hollow-head set screws. The chasers can be easily taken from the tap for regrinding by unlocking the three retaining screws and removing the face plate to permit sliding the chasers forward.

Recorders

C. J. TAGLIABUE MANUFACTURING COMPANY

C. J. Tagliabue Manufacturing Company, Brooklyn, N. Y., announces a new "9" Recorder for temperature and pres-

TAG Recorder



"TOLEDO" NO. 2BR
2½ TO 4 INCH PIPE

FOR BETTER THREADS ON PIPE

"TOLEDO" suggests a No. 2BR Geared Ratchet Adjustable threader for 2½ to 4 inch pipe.

Easy operating. Light weight for easy handling. Separate set of 5 segment dies for each size pipe—makes for easier cutting and longer die life.

No bushings. Long life pipe holder. Three broad-face jaws operated by heavy set screws with size-marked guide bars make for easy accurate centering.

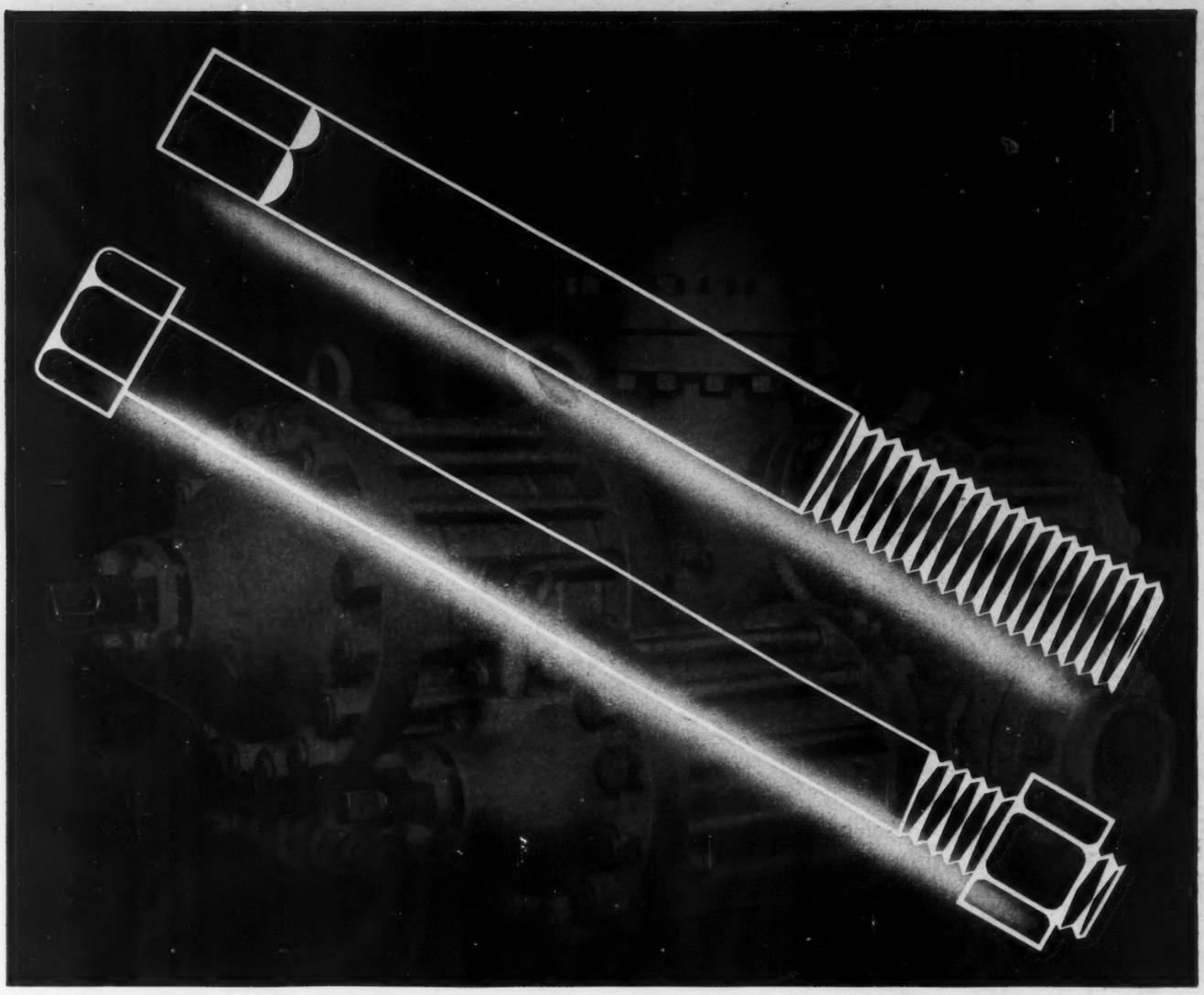
Complete details sent on request or see your dealer.

QUICK, POSITIVE
ACCURATE CENTERING
LONG LIFE PIPE HOLDER

THE TOLEDO PIPE THREADING MACHINE CO.
TOLEDO, OHIO

NEW YORK OFFICE, 72 LAFAYETTE ST.

"TOLEDO"
TRADE-MARK REGISTERED U.S. PAT. OFFICE



WHERE HIGH PRESSURE MUST BE CONTROLLED

When oil drilling encounters pressures of several thousand pounds per square inch, there must be no "ifs" or "buts" about the blow-out preventer's capacity to hold things in check. In one particular type of blow-out preventer (6000-pound test), thrust screw and head bolts play a vital part in preventing accidents and waste. They are made of Chrome-Moly (S.A.E. 4140) steel because:

(a) Chrome-Moly bolt stock can be heat treated in tonnage lots with perfect assurance of consistently developing the combined strength and toughness to withstand heavy loads and to prevent threads from stripping.

(b) Chrome-Moly bolts are readily machinable after heat treating.

Bolt and parts manufacturers seeking to speed up and simplify production, reduce costs, and still give their customers a better product, should send for our free book, ***"Molybdenum in Steel."*** Climax Molybdenum Company, 500 Fifth Avenue, New York.

PRODUCERS OF FERRO-MOLYBDENUM, CALCIUM MOLYBDATE AND MOLYBDENUM TRIOXIDE

Climax Mo-lyb-den-um Company

MOLY

sure, occupying halt the space, but including every feature, of the larger 10- and 12-inch recorders.

With the announcement of this new "9," TAG completes a line of recording instruments with 9-, 10- and 12-inch charts. By compact arrangement in a small case, beautifully finished in black enamel and chromium. Every feature found in the standard recorders is offered in these new dependable instruments. These features include the:

Interchangeable tube system that can be replaced readily and need be checked at one temperature only;

Pen arm bracket supported by bearings at both ends—no backlash—no lost motion;

Positive micrometer pen adjustment;

Safety link for range protection;

Handy door-latch that catches when door is swung closed—fastens when the handle is pushed down;

Convenient chart holders—a turn of the knurled knob releases the gripping fingers and the chart slips over—nothing to remove or lose;

Nine-inch chart with 3-5/16-inch pen travel—assures open graduations for easy reading;

Visible-record stainless steel pen arm;

Removable capillary fountain pen—precision-built on the design of the draftsman's pen.

These are outstanding operating conveniences and mechanical refinements found in all "9" recording instruments.

We're never caught short. We stock all types in all sizes by the thousands. Oil men the world over have come to depend on Kropp for forged steel flanges for they know we won't fail them. Kropp Flanges are forged from a solid block of steel, reduced at least ten times in finishing. They resist the high torsional, tensional and pressure stresses encountered in today's operations. Threads are sharp and clean; bolt holes and bolt circle are exact. Bolt holes are spot faced to provide for even seating of bolts and nuts. Companion, blind, welding, tank, reducing and other type flanges and spuds—Kropp has them in any quantity for immediate shipment.

Send for Stock Flange List 125-A1

KROPP FORGE COMPANY
5313 W. Roosevelt Rd., Chicago

Sales Offices in Tulsa, Dallas, Houston, Pittsburgh, Los Angeles and New York.

Distributed by: Superior Iron & Supply Co., Shreveport, La., and Stores; Continental Supply Co., Dallas, Tex., and Stores; Tom Wheatly, Odessa, Tex., and Stores; The Howard Supply Company, Los Angeles, Calif., and Stores; Republic Supply Co., Houston, Texas, and Stores.

Packing

PACKING ENGINEERING CORPORATION

Packing Engineering Corporation, Cranford, New Jersey, has announced a new development in valve-stem packing wherein sizes now available start at 3/16-inch and increase in size through ¼-inch up to ½-inch. The valve-stem packings under trade name of Ace-O-Pax No. 3, 5, 7 and 8, contain no graphite, make a permanent job and never get hard, thus eliminating scoring, it is claimed. The packings come in convenient dust-proof packages, all materials are U. S. Navy standard, and the ring-segments are very flexible, yet will not break in handling. These packings are specially prepared for such services as general valve stem service against steam, water, air, ammonia, oils, distillates and solvents for temperatures up to 550°F.; for use against any gas or liquid except acids and caustics at any temperature—another type is for all acid and caustic work at all temperatures, and another for use against superheated steam and oils at temperatures from 550 to 1200°F. These packings are shipped in 1, 3 and 5-pound spools and die-molded rings.

Compressor

INGERSOLL-RAND

Ingersoll-Rand, 11 Broadway, New York, recently announced a new heavy-duty Diesel engine-driven compressor, known as the "XVO." This machine is suitable for use wherever economy is the primary consideration, in independent or isolated plants, or when existing power facilities are overloaded, the makers state. It is entirely new in design and combines a horizontal heavy-duty double-acting compressor with a heavy-duty "V" type four-cycle Diesel engine in a single compact and comparatively light-weight unit which operates at a moderate speed.

Sizes are available for actual-free air delivery ratings of 625, 935 and 1250 cfm. for 100 lb. sea-level compression. In addition a variety of air, gas and ammonia compressing cylinders is available for pressures ranging from vacuum to 5000 pounds, and higher.

Nuts and Bolts

THE STANDCO BOLT COMPANY

The Standco Bolt Company, Houston Texas, only exclusive bolt and nut manufacturer in Texas and the Gulf Coast area, has announced that its plant has been revamped within the last few weeks for volume production of machine bolts. A complete line of hex or square heads; mild and alloy steel is carried in stock at all times for the convenience of customers. These bolts can be furnished black, galvanized or Cadmium plated, with any desired length of thread, either S. A. E. or U. S. S. Standard.

Special heads and screw machine products are made to customer's specifications. Standco refinery stud bolts are made from SAE 4140 and SAE 3140 Steel.

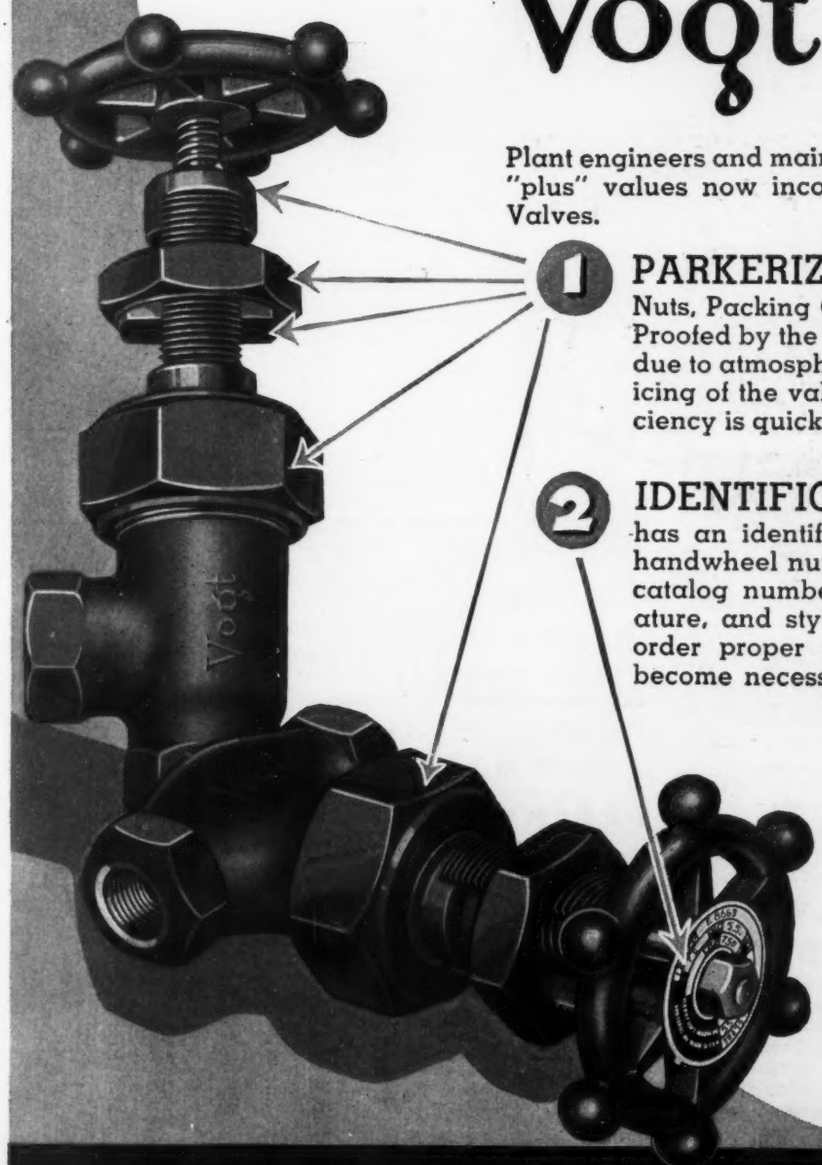
These stud bolts are heat treated before threading to avoid temper cracks.

For refinery use, Standco studs are threaded their entire length for maximum elasticity and strength, which prevents bottle-necking at high tempera-

2 NEW FEATURES

that add to the superiority of

Vogt VALVES



Plant engineers and maintenance men will welcome these new "plus" values now incorporated in Vogt Drop Forged Steel Valves.

1 **PARKERIZING.** Valve Bonnets, Bonnet Nuts, Packing Glands and Packing Nuts are Rust Proofed by the Parker Process. Galling of threads, due to atmospheric corrosion, is eliminated. Servicing of the valve to maintain high operating efficiency is quickly and easily accomplished.

2 **IDENTIFICATION DISC.** Each valve has an identification disc held in place by the handwheel nut. This disc records the valve size, catalog number, working pressure and temperature, and style of trim, thus making it easy to order proper replacement parts if that should become necessary.

HENRY VOGT MACHINE CO.
INCORPORATED
LOUISVILLE, KENTUCKY
NEW YORK CHICAGO PHILADELPHIA
CLEVELAND KANSAS CITY DALLAS

Vogt DROP FORGED STEEL Valves

tures and consequent failure therefrom. Standco studs conform to or exceed the "Class C" requirements of ASTM Specification "A-96-33" for high temperature duty bolting material. Tensile strength: Minimum 125,000 pounds per square inch of cross section. All studs are U. S. Coarse Series thread, except stud bolts larger than one-inch. Sizes larger than one-inch have 8 threads per inch. U. S. Coarse Series profile form of thread is used throughout.

American Standard Heavy Cold Punched, Semi-finished Hexagon steel nuts can be furnished either plain, Cyanide hardened, .40 Carbon oil quenched or .40 Carbon cut from the bar.

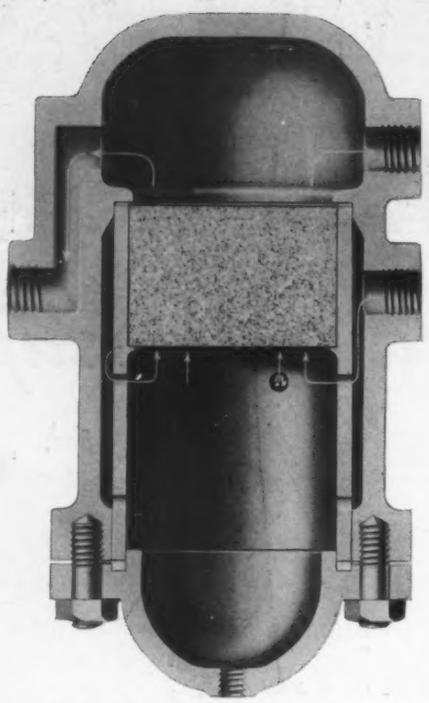
Air and Gas Filters

FISHER GOVERNOR COMPANY

The Fisher Governor Company, Marshaltown, Iowa, announces air and gas filters, designed to meet the increasing demand for a highly efficient filtering device in gas and air lines. These new Fisher Types 360 and 361 filters remove foreign matter and separate free moisture from the air and gas pipe lines with a minimum friction loss. They protect expensive air tools, machines, instruments and other devices against damage and costly service interruptions, while guarding and improving the quality of the finished product.

Fisher filters utilize extremely hard aluminum oxide crystals bonded together as a filter element. This especially manufactured filter element is both acid and heat resisting, and unusually strong. Gases pass through this porous filter with only slight loss due to friction.

The filters may be installed in either



Fisher Type No. 361 Filter

vertical or horizontal pipe lines with standard pipe fittings. They are unusually compact. Their advanced design separates free moisture before gases pass through the element. This reduces the load, and results in longer service life and less frequent cleaning. Suitable drain cocks are furnished. Flanged and bolted bottom castings permit easy, quick removal for cleaning.

The filter body is constructed of high-tensile iron, designed to give full capacity. Those filters with screwed connections are available in sizes ¼-inch to 1¼ inches inclusive, and with flanged connections from 1½ inches to 2 inches.

Stainless Steel Valves

JENKINS BROTHERS

Jenkins Brothers, New York, introduces to industry an advanced line of corrosion-resisting stainless steel valves. By "corrosion-resisting stainless steel," is generally meant some combination of chromium and nickel with small additions of silicon, molybdenum, copper, columbium, titanium, etc., the balance being iron.

These new valves are regularly made of Cooper 18-8 C and Cooper 18-8 SMO, each having a carbon content limited to a maximum of .10 percent. Both are highly resistant to corrosion, but Cooper 18-8 SMO is used under most severe conditions. It is stated that these two alloys will take care of almost 90 percent of all corrosion-resisting requirements. In cases where neither of these valves can be recommended, valves of other alloys will be considered on special order.

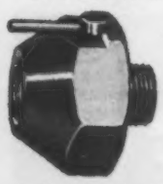
They are available in 7 different styles: solid wedge or double disc Gate valves, union bonnet or bolted bonnet regrinding globe or angle valves, and bolted bonnet "Y" valve; all either screwed or flanged, in sizes ½ to 3-inch.

Tube Cleaning Is Now A ONE MAN JOB

Model 135 Roto Tube Cleaner for 4" Straight Tubes.

NEW ROTO AIR VALVE SAVES TIME AND LABOR

Roto Operating Air Valve for 2½" and 3" Curved Tubes.



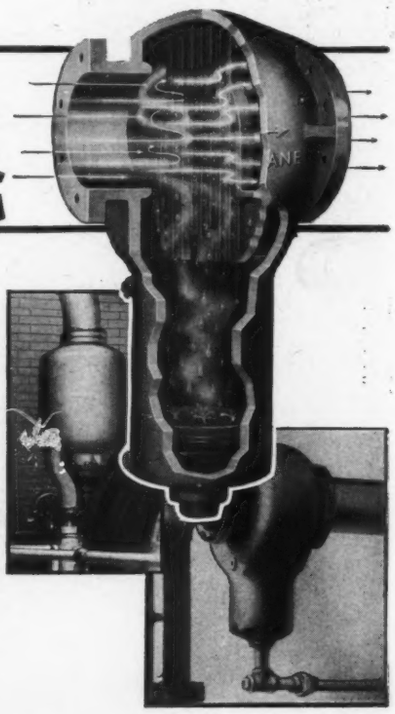
Roto Operating Air Valve for 3¼" Curved Tubes.

The Roto Operating Air Valve is to a tube cleaner what the self-starter and brakes are to an automobile. With it, your operator starts and stops the cleaner himself—instantly. No need for helpers, signals and delay. Easily operated even with gloved hand. A quarter turn either way does the trick. Valve can't close inside tube. Easily attached to all makes of cleaners for straight and curved tubes, 2" or larger. Try the fast, powerful Roto Dictator Tube Cleaner with the new air valve on your toughest cleaning job. Nothing else will ever satisfy you.

WRITE FOR DETAILS

The ROTO Company, Newark, N. J.

Avoid the High Cost of DIRTY, WET, OILY STEAM



Keep It Clean and Dry with

COCHRANE ALL-SERVICE SEPARATORS

Dirty, oily, wet steam, air and gases are costly to equipment and production processes. Cochrane All-Service Separators will completely remove moisture and solid entrainment that may be destructive to expensive steam-consuming equipment—turbines, engines, pumps, evaporators, cooking vessels, stills, etc.

Cochrane Separators assure complete purification due to exclusive construction features of the baffles and ports. These produce a direct, unrestricted fall of the entrainment, prevent the purified steam from passing over the drip area and again becoming contaminated, and minimize pressure loss through extra large port areas.

More than 10,000 plants in every industry have definitely demonstrated the exceptional service and economy of Cochrane Separators.

Write for full information on the construction and performance of Cochrane All-Service Separators.

COCHRANE CORPORATION • 3115 N. 17th STREET • PHILADELPHIA, PA.

COCHRANE

VALVES • TRAPS • SEPARATORS • SPECIALTIES

SIMPLICITY OF DESIGN with Standard Foxboro Parts...

...assures DEPENDABLE REMOTE MEASUREMENT

Note the simplicity of the transmitter pictured at the left. It is composed of standard Foxboro Instrument parts. Every part has been proved ideal for its function in thousands of instruments. In combination, as a pneumatic transmitter, the elements form a unit that is accurate... responsive... and dependable. » » » The entire Foxboro system of Pneumatic Remote Measurement and Control is equally simple and effective. It is definitely a better way to transmit measurement. It permits the location of control in the receiving instrument without loss of accuracy. Receivers may be located as far as 1,000 feet from the transmitter. » » » Learn all about this perfected Foxboro system. Write for a copy of the new Bulletin 227.

THE FOXBORO COMPANY
74 Neponset Avenue, Foxboro, Mass.
Branch Offices in 25 Principal Cities

FOXBORO
REG. U. S. PAT. OFF.

PNEUMATIC REMOTE MEASUREMENT AND CONTROL

NOW EASY TO REMOVE SLUDGE FROM DIESEL CRANK CASES

"TAKES that job right out of the nuisance class," say superintendents who use the new, easy Oakite way to clean out Diesel crank cases. No wonder they like it! Workmen need NOT stay inside the dirty crank cases hour after hour laboriously scraping and wiping surfaces. Instead, with this NEW, different method using Oakite cleaning materials, sludge and other accumulations are swiftly, easily, conveniently removed. . . . *Economical*, too!

TRY THIS QUICK WAY TO RID DIESEL WATER JACKETS OF SCALE AND RUST

Here is another job you can now do easily, with fast-working Oakite materials. Simply by circulating through the system a solution made up with recommended Oakite solution, you can clear out trouble-making rust and scale . . . keep water jackets in A-1 condition in less time, with less effort than ever before. And you can rely on *safe* Oakite cleaning to have no harmful effect on metal surfaces.

Write for free, helpful information on both these cleaning jobs.

Manufactured only by
OAKITE PRODUCTS, INC.
50B Thames St., New York, N. Y.

OAKITE *Certified cleaning*
MATERIALS & METHODS FOR EVERY CLEANING REQUIREMENT

▼ BUSINESS NOTES ▼

KOPPERS COMPANY'S Western Gas division, Fort Wayne, Indiana, has been absorbed by its Bartlett Hayward division, Baltimore, it was announced November 17 by Walter F. Perkins, vice president of Koppers Company. Sales and engineering activities at Fort Wayne have been moved to Baltimore, where they will be consolidated with the Bartlett Hayward organization. This move is another step in the process of corporate simplification which was started by Koppers Company two years ago. The consolidation brings two of Koppers Company's major manufacturing divisions under single management, a step which, it is stated, will enable the organization to provide its customers with more complete sales, engineering and manufacturing service. Perkins will be in direct charge of the combined divisions. All products will be sold, engineered and manufactured under his direction.

WALTER JEHU has been appointed district manager of The Timken Roller Bearing Company's Boston, Massachusetts, office located at 1107 Commonwealth Avenue. Jehu was formerly general manager of The Timken Roller Bearing Company, Ltd., Toronto, Ontario.

JAMES R. TURNBULL has been appointed sales promotion and advertising manager of the Plastics Division of Monsanto Chemical Company, it has been announced by John C. Brooks, vice president. Prior to joining the Monsanto organization, Turnbull was director of sales promotion and advertising for Marshall Field & Company, manufacturing division, New York and Chicago.

Blank & Stoller

F. J. McGOVERN

The Lummus Company has opened a Chicago office at 600 South Michigan Avenue, in charge of F. J. McGovern. McGovern started in the oil business in Tampico, Mexico, in 1920 and has had wide engineering experience in the industry. He has been with The Lummus Company since 1933.

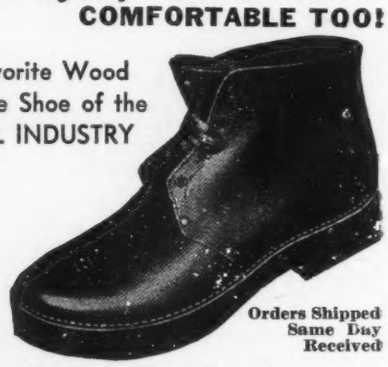
HEWITT RUBBER CORPORATION, Buffalo, New York, announces appointment of new distributors as follows: Joseph Glenn & Sons and their affiliate, E. P. Alexander & Sons, Clifton Heights, Philadelphia, Pennsylvania; Tools & Supplies, Indianapolis, Ind.; Campbell Hardware & Supply, Seattle, Washington; Lawrence Belting Company, New York City, and Everson Electric Company, Allentown, Pennsylvania. These new distributors operate under the exclusive Hewitt franchise, handling the manufacturers' complete line. Each carries a representative stock of industrial rubber goods and specializes in spot warehouse deliveries.

THE annual meeting of the district managers of Pittsburgh Equitable Meter Company and Merco Nordstrom Valve Company was held recently at

Located in Gulf Coast covering refineries and pipe lines only. Technically competent and reliable factory representative, fourteen years in field. Can handle one or two additional select accounts. Box No. 360, The Refiner, Houston, Texas.

"Safety First-" COMFORTABLE TOO!

Favorite Wood Sole Shoe of the OIL INDUSTRY



Orders Shipped Same Day Received

Consider the many possibilities of serious foot injuries facing your employees while at work . . . the costly and annoying service interruptions caused by these expensive foot injury delays . . . and the guaranteed foot protection features only offered by DAVENPORT Wood Sole Shoes. We believe your natural conclusion will be the same as countless other employers. And, that is— DAVENPORT WOOD SOLE SHOES ARE THE COMPLETE ANSWER TO BIG SAVINGS IN AVOIDING COSTLY FOOT INJURIES.

ONLY DAVENPORT WOOD SOLE SHOES have all these PROTECTION FEATURES

- **Uppers attached to soles with wire and staple stitching.**
- **Dust-proof gussets.**
- **Soft, pliable, sole leather counters.**
- **Seams double stitched with heavy wax thread.**
- **High quality, soft felt insoles.**

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World's Largest Exclusive Mfrs. of Wood Sole Footwear

This new blade-type RIDGID cutter wheel

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Low Cost

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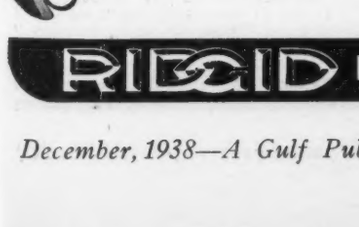
LIKE the blade of a good knife, this RIDGID cutter wheel blade is made of fine tool steel — for more cutting power and stamina. Where ordinary wheels are cut from bar stock, RIDGIDs are coined from tool steel sheets, hammered, heat-treated and cast into a solid hub. Many more cuts per wheel, quicker cutting, practically no burr . . . And thousands of users will tell you that this steel reinforced cutter, guaranteed not to break or warp, always cuts true, twirls easily to size, stands the gaff of hard use. For a tool a good workman can take pride in, for speedier better work and less cutter wheel expense, buy the RIDGID. Ask your Supply House — today.

THE RIDGE TOOL CO., ELYRIA, OHIO

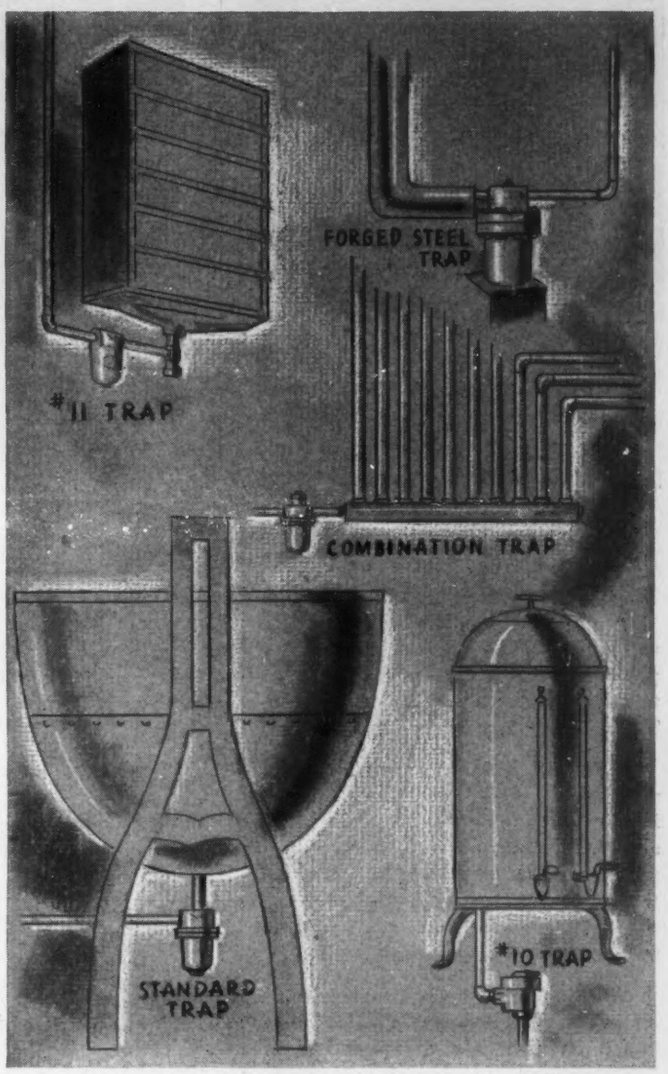
You never need repair RIDGID housings



Guaranteed against break or warp, they save you practically all pipe wrench repairs. For a safe, efficient tool and real economy, buy RIDGID.

RIDGID PIPE TOOLS

There's a SUPER-SILVERTOP FOR EVERY PURPOSE



● From pressures of a fraction of a pound up to 700 pounds per square inch—from capacities of 200 pounds of condensate per hour up to 60,000 pounds—for conditions requiring a trap with the ability to handle extremely large volumes of air or for any other difficult installations—there's an Anderson Super-Silvertop steam trap to suit your requirements in heating and processing work.

In addition, Anderson Super-Silvertops offer the savings from simplified piping and accessibility without removing the traps from the line. Find out all about this trap with the year-ahead design. Write today for complete information.

THE V. D. ANDERSON COMPANY
1942 WEST 96th STREET • CLEVELAND, OHIO

***Anderson* SUPER-SILVERTOP**

Portrait of a "MODERN"

IF this 6-inch elbow had been a flanged fitting assembly, it would have tipped the scale at 242 pounds instead of 27 pounds. Moreover it would have contained 53 pieces instead of just one Taylor Forge Seamless WeldELL.

If it had been a screwed fitting it would have been bulky and difficult to insulate. It would also have had interior shoulders which cause a flow resistance many times greater than the smooth-interior WeldELL. Worse still, on the order of 32% of the pipe wall would have been cut away by threading.

But the engineer was progressive. He chose the modern way: WeldELLS—for added strength and added safety with lighter weight—for smooth-flow interiors —for sightly, easily insulated exteriors —for total freedom from pipe maintenance—for a better job at actually lower cost. Portrait of a "*Modern*" is right!

The Taylor Forge line of seamless steel welding fittings contains the widest range of types, sizes and thicknesses. Large stocks are carried by distributors serving every branch of the oil industry Ask for WeldELLS.

TAYLOR FORGE & PIPE WORKS

General Offices and Works:

Chicago, P. O. Box 485

New York Office: 50 Church Street

★ **TAYLOR FORGE**

WeldELLS

Seamless Pipe Fittings for Welding

★ **Trade Mark Registered**

Officers, district managers and department heads attending district managers conference.

the main offices in Pittsburgh. Colonel W. F. Rockwell, president of the two companies, presided over the sessions. District managers attending were C. R. Zeskey, Kansas City; M. J. Harper, New York; F. G. Swaffield, Columbia, South Carolina; A. J. Kerr, Tulsa; Z. A. Stanfield, Memphis; D. E. Foster, Pittsburgh; C. F. Thomas, Buffalo; H. Boezinger, Los Angeles; A. L. Fritchey, Des Moines; P. C. Kreuch, Chicago; and W. H. Davis, Oakland, California.

SUCCEEDING the late Charles W. Paeschke, Frank A. Frey has been elected president and treasurer of Geuder, Paeschke & Frey Company, Milwaukee, Wisconsin. Frey has been associated with the company since 1913, having served both the manufacturing and financial ends of the business, and acting in the capacity of executive vice president and treasurer since 1936. Henry F. Millmann has been elected executive vice president and general manager. August K. Paeschke, who is the son of the late Charles W. Paeschke, has been re-elected secretary of the company.

HERBERT J. WINN, retiring president of the 87-year-old Taylor Instrument Companies, becomes chairman of the board of directors and is succeeded in the presidency by Lewis B. Swift, who has served as vice president in charge of engineering and research. Karl H. Hubbard has been appointed chief engineer, in charge of engineering research and design, and Dr. H. L. Mason will succeed him as head of the research division.

Swift joined Taylor Instrument Companies in 1904 after graduation from high school. In 1908 he entered Cornell University, but continued to work for Taylor during vacations. After receiving his M.E. degree in 1912, he rejoined the company on a full-time basis. He was in the industrial sales department until 1919 when he organized and took charge of the sales engineering department.

In 1928, Swift was elected a director of the company, and in 1929 he became chief engineer. Since 1934 he has been

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PRODUCTS

Flanges, Weldells, Welding Reducers, Welding Tees, Flanged Unions, Special Flanges, Orifice Flange Unions, Boiler Nozzles, Welding Neck Nozzles, Spiral Welded and Spiral Riveted Pipe.

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1500 POUND
WELDING END
GLOBE VALVE
SPUR GEAR OPERATED

1500 POUND
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GATE VALVE
WITH BY-PASS
AND MOTOR OPERATED

Powell steel valves have made a definite mark in the engineering world for greater efficiency in low and high pressure control equipment. Write for detailed information regarding your particular problem!

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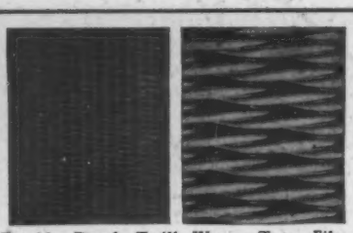
THE WM. POWELL CO. CINCINNATI, OHIO



Double Dutch Twill Weave Type Filter Cloth originated by us. Known and used the world over. The exact size of mesh is shown at the left. At the right the same mesh is shown magnified.

WIRE CLOTH

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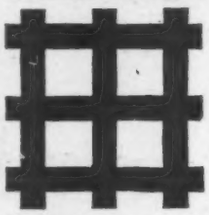
REFINERS

We make every size, weave, and mesh, from the world's finest to 4" space. The world's finest is our 400-mesh—both ways—160,000 square openings per square inch. 0.001 in. dia. wire; .0015 in. opening.

At the right, above, we show our 100 mesh cloth; .0055 in. space; .0045 in. dia. wire. Below: ¼-inch space; 0.120 dia. wire.



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Sales Representatives: Chicago, Boston, Detroit, Havana, Houston, Los Angeles, San Francisco, Tulsa

NEWARK

Bill says

For Safety Specify KERLOW FLOORS

KERLOW gratings and safety steps are made in all riveted and rectangular types and cut to fit your exact requirements.

For: Subways, boiler room floors, walkways, fire escapes, platforms, areaways, sidewalks, trench covers. KERLOW Bridge Paving (open and solid types).

Ask about **Kerlow "BOLDEI" Safety Steps.** —The latest advancement in safety steps.

Write for Catalog

Representatives in Principal Cities

KERLOW STEEL FLOORING CO.

Dept. R

210 Culver Ave. Jersey City, N. J.

vice president in charge of engineering research and design.

Winn, retiring president, has been with Taylor nearly 46 years, and has served as president and treasurer for 25 years. When he joined the company in March, 1893, the Taylor line was composed of only household thermometers, clinical thermometers, and mercurial barometers; and the combined office and plant forces did not exceed 60 employees.

During Winn's association with the company, he has seen the business develop from one of Rochester's pioneer industries into the world's largest manufacturers of thermometers and barometers. The normal working force has increased to 1200, and the Taylor line now includes literally thousands of different instruments: For household and domestic science purposes; meteorology; medical diagnosis and treatment; as well as the vast specialized requirements of industry in measuring, recording and controlling temperature, pressure, rate of flow, and liquid level.

Winn will maintain an active interest in Taylors, as well as in his numerous financial and philanthropic activities.

Other officers chosen by the board of directors include: Vice presidents, P. Richard Jameson, Henry W. Kimmel and Fred K. Taylor; treasurer, Herbert J. Noble; secretary, Henry W. Kimmel; assistant secretary, George H. Taylor.

RESEARCH work which goes on behind the scenes in the plant of a large manufacturer of valves, fittings, plumbing and heating equipment and pumps was revealed at an open house held by Crane Company, at its Chicago Works in the middle of November. The occasion was inspired by a notable expansion in the Crane research and engineering program.

Although research work has been a part of the Crane program for half a century it has been continually enlarged in recent years until today it occupies two two-story buildings with a total floor space of 86,000 square feet and a personnel of 285. The staff ranges all the way from experts in metallurgy to specialists in the field of ceramics—a body of engineers spending their entire time in the work of controlling the quality of present products and looking ahead to their improvement.

As Charles B. Nolte, president of Crane Company, says in the foreword to a book on the Crane Research Laboratories, "Crane Company is dedicated to the philosophy that only through continuing a well organized program of research can it best serve its employees, its stockholders, the users of its products and society in general."

M. B. SKINNER COMPANY, South Bend, Indiana, makers of repair clamps for steel and cast iron pipe, has been issued Trade Mark No. 359892, which protects the trade name "Skinner-Seal," used in connection with Skinner products.

The word "Skinner-Seal" clearly defines the basic principle of the Skinner pipe repair method—to seal the gasket in each of nine different styles of pipe leak repair clamps.

Although the trade name "Skinner-Seal" is new, the Skinner pipe repair method was introduced in 1898, and Skinner clamps have been widely used since that time.

ROBERT E. LANIER & Company, Electric Building, Houston, has been appointed distributor in Texas, Oklahoma, Arkansas, Louisiana and Mississippi for Amercoat, cold-applied corrosion-resistant coatings manufactured by American Concrete and Steel Pipe Company of South Gate, California. Amercoat Sales Agency, 5905 Pacific Boulevard, Huntington Park, California, is general distributor for the product.

The new Houston distributor will carry a warehouse stock and sales will be under direction of Everard W. Baker.

Other warehouse stocks of these coatings are carried by Hume Pipe of New England, Inc., Swampscott, Mass.; Gregg Company, 1418 Walnut Street, Philadelphia, Pa., and Thomas A. Short Company, 575 Howard Street, San Francisco, California.

Creep Stress Data Cards

CREEP stress data on the various Croloys and other materials supplied in tubular form by The Babcock & Wilcox Tube Company, Beaver Falls, Pennsylvania, are available on a handy letter size card to those interested in the design of tubular equipment for high-temperature, high-pressure service. The data were obtained, in nearly every case, by tests on commercial materials—the creep tests averaging 3000 hours duration. The data are believed to be accurate, conservative, and suitable for design purposes, with proper allowances for corrosion and oxidation of the parts.

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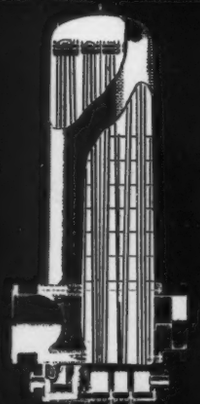
FRACTO CONDENSERS

for High Pressure and Temperature.



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Fracto Control

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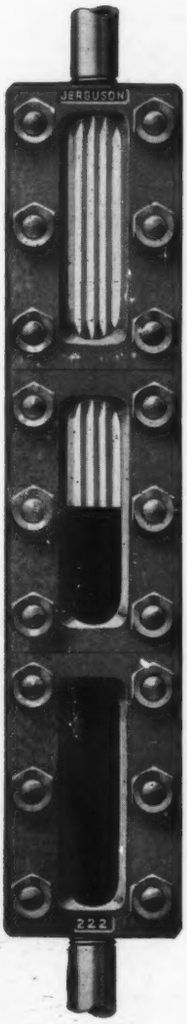

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Empty space shows

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Ideal for gasoline, kerosene, oil, etc. . . . no matter what the color of liquid.

Jerguson Transparent (thru vision) Gages, for showing color and density of liquids, are just as accurate and as easy to read.

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There's a JERGUSON GAGE for your plant.

Jerguson Gages are best
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GARLOCK 875

GAS COMPRESSOR METAL PACKING

GARLOCK 875 Metal Packing is made of improved, non-abrasive iron. Gives long, dependable service on high or low stage gas compressors.

IMPROVED!

FOR LONG SERVICE

New metals and new processes are enabling progressive manufacturers to build greater wear-resistance and longer life into their products. So it is with Garlock Metal Packings. Our improved iron was developed after exhaustive, accelerated-wear tests in one of America's leading universities. In actual service it has conclusively demonstrated its superiority.

Frequent periodic tests guarantee the uniformity of this quality controlled iron. These new, improved Garlock Metal Packings will give remarkably long, economical service.

THE GARLOCK PACKING CO.
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Tulsa, Okla. Houston, Texas
Los Angeles, Calif.

GARLOCK

CATALOGS . . . BULLETINS

Helpful Publications Which Manufacturers Will Be Glad to Send Free for the Asking

Nickel Alloys

The International Nickel Company, Research and Development Division, 67 Wall St., New York, announces the revised edition of its Technical Bulletin T-7 "Properties and Uses of Inconel," which contains many changes from the preceding edition. The text has been re-arranged and, in many parts rewritten extensively. Revisions and additions have been made in the tables of "Physical Constant" and "Mechanical Properties." New data on short-time, high-temperature tensile properties have been plotted, and a limited amount of new creep test data has been added. There are added sub-sections on compression, shear, torsional and fatigue properties, and the sub-section on spring properties has been rewritten. The section on "Corrosion Resistance" has been revised completely, and the section on "Working Properties" has been extensively revised. Several other changes and revisions have been made to the end that the new edition is of added interest and value.

Control

The Foxboro Company, Foxboro, Mass., has published a new 7-page booklet, No. 227, under the title "Remote Measurement and Control," which describes a new pneumatic transmission system for remote measurement and control of flow, temperature, level and pressure. Typical installation illustrations are supplemented by explanatory captions for the four types of transmission and a cutaway photograph showing the interior construction of the pneumatic transmitter is included as well as a schematic drawing and complete details of operation of the entire remote transmitter system.

Control

Mason-Neilan Regulator Company, Boston, Mass., has published Bulletin No. 2345-A dealing with Air-Operated Controllers, which are for use with temperature, pressure, flow and liquid level. The 26-page bulletin is replete in sectional views of the equipment, schematic drawings, photographs, and all pertinent engineering information.

Pumps

Waterous Company, St. Paul, Minnesota, has published Bulletin No. C-134 describing the features of the Waterous Rotary Pump and covering such features as self priming, no contact between rotors, hydraulic balance, improved rotor design, improved stuffing boxes, etc. The bulletin is completely illustrated with photographs and drawings supplementing the engineering type descriptions.

Control

Natural Gas Equipment Company, Los Angeles, has published Bulletin No. 102-R, describing the improved column type liquid-level controller. Adjustability of the controller has been simplified and its operating level adjustment extends through the instrument case so that changes in level may be made by adjustment of the hand wheel. A pressure gauge is included which indicates pressure on the diaphragm of the controlled valve. These improvements and others are explained in detail.

Protective Coating

The M. W. Kellogg Company, 225 Broadway, New York, has published descriptive literature covering the recently developed Thur-Ma-Lox protective coatings for steel. These coatings will stand 1800° F. and if applied as in ordinary paint practice the coatings will resist and give continued protection against acids, alkalies, rain or snow and will withstand extreme thermal shocks. In the petroleum industry they are recommended for oil stills, stacks, flues and breechings, towers, tubes, etc. They have been thoroughly tested in a number of industries before their general offering to the trade.

Control

The Bristol Company, Waterbury, Conn., in Bulletin No. 517, describes air switches for local and remote control manually. These switches are available for control of either electrically- or air-operated valves. The line of air switches includes throttling valves, toggle switches, selector switches, safety switches, air-electric switches and pilot valves. In Bulletin No. 521 the company describes control instruments for the protection of gas-fired furnaces and ovens. The two models available are Factory Mutual approved and are completely described with schematic drawings of practical applications.

Diesel Engine

Ingersoll-Rand Company, 11 Broadway, New York, has published Bulletin 10110, 40 pages describing the new Type S Diesel engines, which are heavy-duty machines of the continuous service, compact engine type for stationary or marine-electric application. It is a four-cycle, single-acting, solid-injection engine of modern enclosed type having complete force-feed lubrication, wet liners, shell bearings, and other refinements. The engine is built in sizes of 3, 4, 5, 6, 7, and 8 cylinders and rated at 175, 230, 290, 350, 405, and 460 horsepower, respectively, for 600 revolutions per minute.

Gas Indicators

Mine Safety Appliances Company, Pittsburgh, in Bulletin No. DN-3 describes the new M.S.A. Methane Tester, a pocket-size, easily operated device which can be used on the job by any workman. The instrument gives positive, immediate indication of the methane content of air in concentrations much lower than can be determined by a flame safety lamp. Accuracy is stated to be comparable to that obtained by analysing bottle samples with an Orsat gas analysis apparatus. The instrument is approved by the U. S. Bureau of Mines. Bulletin No. EB-3 details advantages of the M.S.A. Displacement Blower for hose masks. The new M.S.A. Air Line Respirator is described in Bulletin No. CS-7. Double exhalation valves are a special feature of this respirator, providing very low resistance to air flow.

Welding

Lincoln Electric Company, Cleveland, Ohio, has published a well illustrated and comprehensive 20-page booklet telling of the new arc welding technique made available by the Lincoln "Shield-Arc" Welder with self-indicating dual continuous control. Operation of the welder control is discussed in detail and the bulletin lists and explains 31 features of the performance and construction of the welders. The company has also published Bulletin 401-A in which procedures for producing all types of welds in mild steel, for welding all metals used to any extent industrially and for applying surfacing metal to meet any type of wear-action in service, are given.

Cleaning

Oakite Products, Inc., 14 Thames St., New York, has published a new 12-page booklet, "Greater Industrial Safety," which relates how modern cleaning methods and materials effectively promote increased safety in plant, product and personnel. Considerable attention is devoted to eliminating commonly recognized fire hazards and avoiding certain well-known occupational hazards. Safeguarding health through proper plant sanitation maintenance is also discussed.

Gas Booster

The Fisher Governor Company, Marshalltown, Iowa, has published a 24-page catalog No. 38 "Fisher-Kind Gas Pressure Boosters" for low-, intermediate- and high-pressure gas distribution systems. The booster can be used for reduced pressures in either inches of water column or ounces, but finds its widest application for pounds per square inch pressures with values up to 300 pounds per square inch or higher.

Machinery

Worthington Pump and Machinery Corporation, Harrison, N. J., recently published the following descriptive literature: Bulletin W-318-B1B — "Worthington Balanced Multistage Volute Centrifugal Pumps for Pipe Line Service"; Bulletin W-423-B5 — "Worthington Vertical Triplex, Single-Acting Power Pumps"; W-475-M2—"Worthington Rotary Pumps for Cargo-Unloading from Barge to Tanker," and W - 200 - B4 — "Worthington Hydraulic Tube Washer for Surface Condensers."

Generators

Griscom-Russell Company, 285 Madison Avenue, New York, has published Bulletin 520 on "Bentude Steam Generators." A practical evaporator for generating steam from raw untreated water by using heat in hot gas oil or cracking coil tar, is described. The units effectively overcome the double problem of keeping the outside of the evaporator tubes free from hard-water scale accumulation and prevent clogging of the tube interiors from tarry or dirty liquids, it is stated. The principle of operation of these units is concisely described and the bulletin includes exterior views, interior views, and sectional diagrams which graphically explain their design and construction.

Cements

Smooth-On Manufacturing Company, Jersey City, N. J., has issued a revised and enlarged edition of the Smooth-On Handbook, describing the Smooth-On Metal Cements and products, illustrating their application by working diagrams, and explaining the steps and relative advantages of the various application methods. Smooth-On compositions are most used in stopping fluid and pressure leaks, tightening loose parts, anchoring in metal, masonry and wood, filling surface flaws in metal castings, hardening and waterproofing concrete floors and walls, and weatherproofing joints in structural parts.

Alloys

The International Nickel Company, 67 Wall Street, New York, has published two new technical bulletins. Bulletin T-9 presents technical information on the "Engineering Properties of 'K' Monel." Bulletin T-4 presents technical information on "Methods of Fabrication of Nickel-Clad Steel Plate." Both of these publications are well illustrated and include much pertinent engineering information of value to those interested in metals performance.

Valves

The Edward Valve & Manufacturing Company, East Chicago, Indiana, has just printed an 8-page bulletin entitled "Just One—Of the Big Three." This bulletin contains reprints of recent advertisements to valve users discussing methods used in the Edwards laboratories for research and production testing of valve materials. Photographs show the equipment and types of tests used in modern high-temperature metals investigation and the aims and results of these tests are described.

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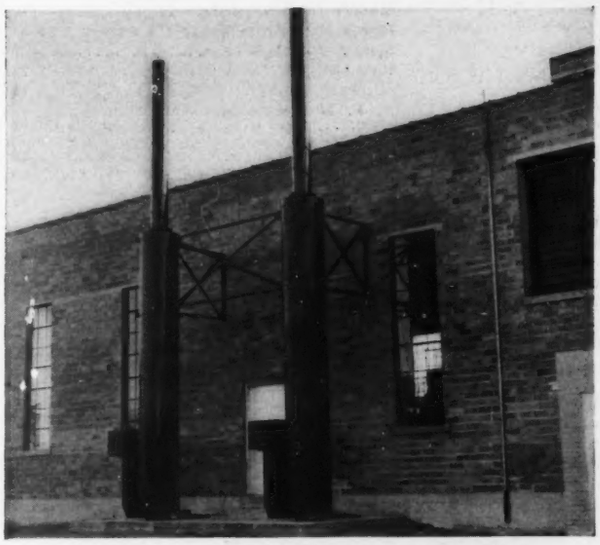

THESE MODEL DO4 MAXIM SILENCERS REDUCE EXHAUST NOISE TO A WHISPER

Maxim Model BRX silencers were designed especially for gas engines. Of extra heavy construction to withstand exhaust line explosions, Model BRX silencers are popular because they can "take it."

Heavy duty MAXIM SILENCERS are built in three models: BRX4 for high degree silencing; BRX2 for medium degree silencing; and BRX1 for good muffling.

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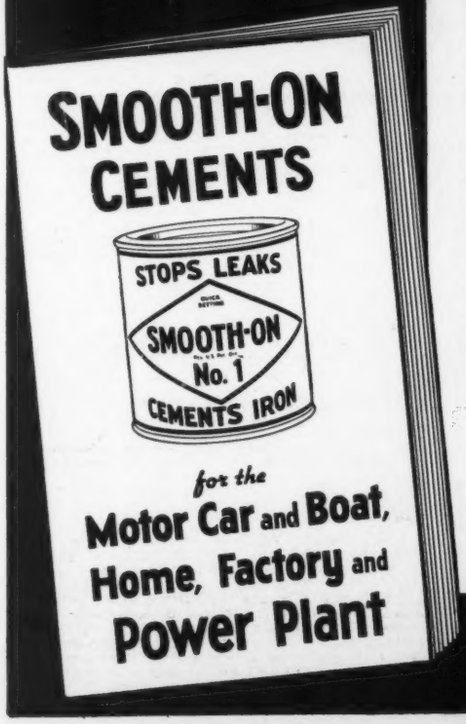
Now Ready — and SENT FREE!

NEW ENLARGED EDITION — 25% more information and diagrams
A veritable encyclopedia of good repair and construction practice



This Handbook enables any Engineer to make countless routine and emergency repairs quickly, easily, at low cost and with assured results. By following its instructions and diagrams, you can prevent or stop fluid and pressure loss at cracks and joints in boilers, steam, air or pump cylinders, valve decks, pipe lines, condensers, feed heaters, stills, heat exchangers, tanks, etc., seal porous spots in cast metal, tighten stripped bolts, nuts or screws, anchor parts to wood, metal or masonry, make rigid machine base contacts and oil-proof foundations, seal cracks against the corrosive action of moisture, prevent the entrance of ground water through floors, walls, sumps, machinery pits, etc., harden or patch concrete floors—all with least effort, time loss and expense.

For over 40 years the Smooth-On Iron Cements have been used in power plant repair and construction work. Constant improvement in the composition of the different Smooth-On Cements is being made by laboratory experimentation. For instance, the hardness, strength and working time of Smooth-On Iron Cement No. 1 have recently been doubled. Easy to apply, without tools or heat. Just mix with water.

The new Handbook is up-to-date with new uses found by test and from experiences of the many Smooth-On users. Its information is valuable, and should be on every Engineer's desk.

MAIL THIS COUPON for YOUR COPY

and get Smooth-On in 1-lb. or 5-lb. can or larger package from your supply house.

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Please send SMOOTH-ON HANDBOOK, 1939 Edition.
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Address_____
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Do it with SMOOTH-ON

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Take Composite Samples With Proportioneers' Sampl-O-Unit While Unloading Gasoline or Crude

1. **BOTH QUANTITATIVE AND QUALITATIVE COMPOSITE SAMPLE** assured by complete flow responsiveness.
2. **FRESH SAMPLE AND INSTANTANEOUS RESPONSE** assured by continuous by-passed flow through sampling chamber.
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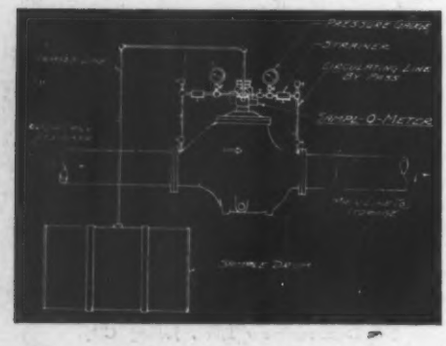
4. **NUMBER OF SAMPLES PER MINUTE EASILY VARIED** from 5 to 100 by interchangeable gears.

See Pages 253-256 in Composite Catalog of Refinery Equipment — or write



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